U.S. JOINT FORCES COMMAND

JOINT CONCEPT OF OPERATIONS (CONOPS)

UNMANNED AERIAL VEHICL TACTICAL CONTROL SYSTEM (TCS)

VERSION 1.2.2

30 May 2000

DEPARTMENT OF DEFENSE
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Subject: Unmanned Aerial Vehicle (UAV) Tactical Control System (TCS) Joint Concept of Operations (CONOPS)

1. The attached joint CONOPS document is forwarded for implementation and use as appropriate.

2. U.S. Joint Forces Command is the designated lead CINC for joint sponsorship of the TCS program. As such, U.S. Joint Forces Command provides oversight and direction for warfighter involvement in the TCS program and conducts liaison directly with the Program Manager regarding joint operational employment issues. U.S. Joint Forces Command chairs the Joint Warfighter Planning Group (JWPG) which developed, reviewed, and coordinated this joint CONOPS. This CONOPS has the concurrence of U.S. Joint Forces Command components and the TCS Program Manager. It has been coordinated with the Service headquarters.

3. This CONOPS is written to enable U.S. Joint Forces Command warfighters to train with and employ the UAV Tactical Control System. U.S. Joint Forces Command components are encouraged to develop complementary UAV CONOPS documents with more definitive, Service-specific TCS employment guidance for their forces. Likewise, theater CINCs may use this document as a template for developing TCS joint employment guidance tailored to their AOR. As the system matures and operational employment experience is gained, the concepts and procedures described herein will be updated to reflect lessons learned. Accordingly, this is a living document. Comments and suggestions are welcomed for inclusion in future versions of this joint concept of operations.

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Attachment:
UAV TCS Joint Concept of Operations

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1.0 EXECUTIVE SUMMARY

The advantages of an unmanned aerial vehicle (UAV) system that benefits from interoperability and commonality have been recognized since Congress directed the Department of Defense (DoD) to consolidate divergent UAV programs in 1988. Early efforts focused on the creation of a common control element operating within established standards and protocols, interoperable with other UAV and battle management systems. The maturation of such a system was necessary to ensure the proper integration of UAVs into the existing and future battleforce structure and reduce development costs for follow-on UAV programs. The culmination of these efforts produced the UAV Tactical Control System (TCS) concept.

The TCS concept was developed into an acquisition category II (ACAT II) program under the aegis of a program office within the Program Executive Office for Cruise Missiles and UAVs (PEO-CU). All Services provide personnel to support TCS program management.

TCS software, host computer software-related hardware and TCS required ground support hardware enables various levels of UAV control and imagery and data dissemination interoperability with the RQ-1A Predator Medium Altitude Endurance (MAE) UAV, and future tactical UAVs (TUAVs) and MAE UAVs. TCS also has the objective capability of receiving Global Hawk High Altitude Endurance (HAE) UAV payload information. In addition, TCS incorporates the technical interfaces necessary for the dissemination of UAV imagery and data to selected joint and Service command, control, communications, computers and intelligence (C4I) systems. The TCS concept was endorsed by the Vice Chairman, Joint Chiefs of Staff, the Joint Requirements Oversight Council (JROC), and the Under Secretary of Defense (Acquisition and Technology). A TCS Operational Requirements Document (ORD) was signed in February 1997. An updated ORD supporting progression to Milestone II (MSII) was approved by the JROC in February 2000.

TCS realizes its full operational potential when integrated in an institutionally, organizationally, and intellectually joint force. When properly employed and intelligently integrated into joint military operations, TCS delivers a capability that significantly enhances the contribution of joint force UAV assets. For the first time, units at all echelons, even those without organic UAVs can be equipped with TCS to provide the capability to interact with a UAV and assume responsibility for the management of its output in direct support of a tactical operation. TCS is the product of innovative thinking and its capabilities are wholly aligned with the concept of joint operations as envisioned in Joint Vision 2010. TCS is an integral element in the joint target engagement system of integrated sensors, communications and precision weapons, and enables real-time, not prearranged, decision making.

UNIX-based and scalable, TCS functionality can be tailored to the user. Augmented with TCS, the warfighter is provided options ranging from passively receiving UAV payload products to full control of multiple air vehicles. The true warfighting potential of TCS is in the level of operational flexibility it provides to warfighters at any echelon of the force. By enabling warfighters at any echelon to interact directly with tactical, JTF, and theater level UAVs, TCS substantially magnifies the warfighter s joint combat effectiveness. Hence, TCS leverages the inherent maneuverability, firepower, and initiative of individual units with the proven operational advantages of UAVs to enhance force-wide battle management and execution.

TCS is scheduled to complete the Program Definition and Risk Reduction phase (Phase I) of a multi-year program in early fiscal year 2000 (FY 00). Because TCS integrates with individual Service UAVs, a TCS MSII decision in second quarter FY 00 will enable the program to proceed with required integration efforts. MSII decisions for individual Service UAV programs will include TCS. The program will be entering an engineering and manufacturing development cycle that will integrate TCS into the Service UAV programs and include developmental test/operational test (DT/OT). Completion of this phase will lead to full rate production and operational fielding of production TCS systems within the Service UAV programs.

TCS software is Defense Information Infrastructure/Common Operating Environment (DII/COE) compliant and operates on current Service hardware: Sun/SPARC (Air Force), CHS-II/SPARC-20 (Army/Marine Corps), and TAC-N (Navy). The standards, protocols, interfaces, and formats developed belong to the government and serve as the foundation for future UAV development. These commonality features promote UAV system interoperability and alleviate many of the current limitations associated with stand-alone, stovepipe systems that have been incompatible with fielded battle management systems. Standard TCS interfaces to joint and Service C4I systems ensures UAV compatibility with fielded combat systems and supports connectivity to lower command echelons. The TCS human computer interfaces (HCI) may become the standard for future UAVs, supporting the establishment of standard procedures for operating the family of UAVs. Accordingly, changes to a C4I or air vehicle system will only need to be incorporated in the TCS open architecture and not in each UAV or C4I system.

TCS construction is modular which promotes the use of common hardware and facilitates increasing or decreasing UAV control capability by adding or removing system components. Increasing or decreasing host computer hardware and ground support components permits TCS to function at five discrete levels of TCS-to-UAV interaction ranging from receipt and transmission of secondary imagery and data, to full control and operation of a UAV including takeoff and landing.

The five levels of interaction include (each level of TCS capability incorporates the functionality of all lower levels):

Level I	Receipt and transmission of secondary imagery or data.
Level II	Receipt of imagery or data directly from the UAV*.
Level III	Control of the UAV payload.
Level IV	Control of the UAV, less takeoff and landing.
Level V	Full function and control of the UAV to include takeoff and landing.

* From the UAV or its supporting satellite through the TCS datalink

The TCS system operates primarily by internally and externally interfacing specific hardware and software to achieve the functionality of a specific configuration. Internal interfaces support interaction between the various hardware and software components within the TCS core and its associated subsystems. External interfaces involve inputs and outputs between the TCS system and supporting equipment. TCS functionality will be available in three basic configurations: a land-based (LB) high mobility multi-purpose wheeled vehicle (HMMWV)-shelter configuration, a ship-based (SB) configuration, and in the RQ-1A Predator system ground control station (GCS).

TCS is interoperable at all levels of interaction with identified joint, Service, and NATO C4I systems. This facilitates the accurate and timely dissemination of UAV products to multiple users, and eliminates the need for legacy and future UAVs to develop their own system-unique interfaces with the myriad of C4I systems. TCS workstations are capable of receiving, displaying and transmitting a complete complement of still and motion imagery. TCS supports the dissemination of data in established tactical communication formats. However, TCS is not configured with its own organic communications nor does its integration into a UAV system automatically provide additional bandwidth. TCS must be integrated into existing theater operational architectures and function within available communications management constructs. Types of products desired and timeliness of delivery will drive TCS-associated communications requirements and priority. Consequently, judicious communications planning and management are required to facilitate warfighter-useful, real time connectivity between TCS and other nodes.

To effectively plan the employment of TCS in the prosecution of Joint Force Commander objectives, centralized planning and tasking processes functioning within existing joint force organizations and structures are required. At the joint force level, the JFC will define supported-supporting relationships among staff organizations and component commanders to accomplish TCS-equipped unit employment planning, tasking, and execution.

Specific training and qualification is required to employ TCS. With both TCS-specific training and qualification, and any required Service specific air vehicle/payload training and qualification, personnel will be capable of effectively employing TCS. Initial TCS and air vehicle-specific training requirements are a function of trainee experience and the TCS operating level being trained to. Operator UAV-specific currency in the level of operation to be performed is also required for TCS operators conducting operations at Level III and above. Moreover, to satisfy Federal Aviation Administration (FAA)/International Civil Aviation Organization (ICAO) requirements, air vehicle operators will require training and qualification in appropriate controlled airspace procedures.

This joint concept of operations (CONOPS) details TCS employment options available to the JFC. It is designed to assist the warfighter in TCS-related planning and execution coincident with the conduct of military operations. It also provides an operational framework for the TCS development and Service operational testing communities. The CONOPS provides a descriptive overview of the capabilities and limitations of TCS to assist the tactical commander in deciding when, where, and how to deploy and employ TCS equipped units. The CONOPS is a living document and will be updated as exercises, demonstrations and tests reveal improved tactics, techniques, and procedures (TTP). **The goal is to periodically review, update, and coordinate the CONOPS to reflect modifications and upgrades in hardware, and software, and to presage changes in joint doctrine and TTP.**

The TCS Joint CONOPS provides the conceptual framework for future employment principles that will leverage the full potential of TCS technology in achieving new levels of effectiveness in joint warfighting. Accordingly, some UAV interoperable employment and control concepts presented in this document are more applicable to future joint operations and are not fully consistent with present Service CONOPS for legacy UAV systems or current Service UAV employment philosophy. Specific differences from individual Service documents that may impact current TCS employment as discussed in Section 4 are annotated throughout this CONOPS.

SECTION 3. TACTICAL CONTROL SYSTEM (TCS) DESCRIPTION

3.1 PURPOSE. This section describes TCS system capabilities, the five levels of TCS interaction, system components and TCS configurations, interoperable functionality with the various families of UAVs and designated C4I systems, and summarizes system operating performance and limitations.

3.2 SYSTEM CAPABILITIES. TCS is a software-focused program that provides a scalable and modular capability to control UAVs on existing computer systems and an interface with current and future C4I systems to disseminate UAV sensor products. Varying hardware configurations allows TCS to function at five levels of interaction ranging from receipt and transmission of secondary imagery and data to full control and operation of a UAV to include takeoff and landing. Modularity allows the use of common hardware and facilitates increasing or decreasing capability by adding or removing system components. Consequently, TCS can be configured to meet various warfighter needs coincident with deployment or operational constraints. TCS capabilities are primarily provided through software, host computer software-related hardware, and TCS related ground support equipment (antenna, cabling, etc.). TCS enables interoperability with the current RQ-1A Predator system, and all future tactical UAVs (including the Army TUAV and Marine Corps/Navy VTUAV) and MAE UAVs. In addition, TCS has the objective capability of receiving HAE UAV payload information.

TCS software operates on current Service hardware: Sun/SPARC (Air Force), CHS-II/SPARC-20 (Army/Marine Corps), and TAC-N (Navy). The Air Force will incorporate TCS software and selected components into the existing RQ-1A GCS. For Army, TCS will be an integral part of the HMMWV-based TUAV GCS. For Marine Corps, TCS will be an integral part of the HMMWV-based VTUAV GCS. For Navy, TCS will be the VTUAV control system and support UAV operations from ships, submarines, and temporary sites ashore.

System capabilities enable operators to:

- Format, send, and receive tactical communications messages
- Send and receive voice communications
- Establish TCS to TCS connectivity
- Interface to a wide range of C4I systems
- Receive and disseminate analog video and NITF digital imagery
- Retrieve and disseminate payload data
- View payload data from multiple payloads simultaneously
- Control and monitor multiple UAV payloads simultaneously
- Plan UAV missions
- Control and monitor multiple air vehicles simultaneously
- Monitor the performance and status of the TCS system

TCS software is developed for open architecture and provides operators the necessary tools for computer related communications mission tasking, route flight planning, mission execution, and data processing. The software provides high resolution, computer generated, video graphics that enable operators trained on one UAV system to control different types of UAVs or UAV payloads after appropriate formal training. TCS core software is Global Command and Control System (GCCS) compliant, non-proprietary, and the architectural standard for future UAVs.

TCS provides a standard HCI for the family of UAVs to simplify user operations and training, and to facilitate seamless integration into individual Services joint C4I infrastructure across all levels of interaction.

TCS does not contain organic communications capability. Therefore, communications requirements to support TCS must be met with existing systems and architectures. In the case of UAVs that have organic communications capability, additional C4I interfaces may be provided by TCS.

3.3 LEVELS OF INTERACTION. TCS is interoperable with different types of UAVs and UAV payloads across five levels of interaction. The levels of interaction are:

Level	Capability
Level I	Receipt and transmission of secondary imagery or data.
Level II	Receipt of imagery or data directly from the UAV*.
Level III	Control of the UAV payload.
Level IV	Control of the UAV, less takeoff and landing.
Level V	Full function and control of the UAV to include takeoff and landing.

* From the UAV or its supporting satellite through the TCS datalink

Each level of TCS capability incorporates the functionality of all lower levels. For example, Level V, in addition to UAV launch and recovery, also provides the operator full capability to control the air vehicle in flight, control payload operations, receive UAV products directly from the air vehicle, and disseminate those products to other TCS-equipped units. Figure 3-1 provides the five levels of interaction and the functionality provided at each level.

LEVELS OF INTERACTION / FUNCTIONALITY	
Level	**Functionality**
SENSOR DATA RECEIPT/TRANSMISSION I. INDIRECT PATH (via C4I SYSTEM, TCS, or MCE) II. DIRECT PATH* (UAV to USER)	¥ OPERATIONAL COORDINATION ¥ RECEIVE & PROCESS SENSOR DATA ¥ ANALOG (EIA-170) ¥ DIGITAL (NITF, OTHER) ¥ DISPLAY SENSOR DATA ¥ OVERLAY ON GEO (MAP) DISPLAY ¥ ANNOTATE ¥ TRANSMIT SELECTED DATA VIA COMMS SYSTEMS (SECONDARY DISSEMINATION)
III. SENSOR CONTROL & DATA RECEIPT/USE	¥ LEVEL I & II FUNCTIONALITY plus ¥ DIRECT CONTROL OF SENSOR PAYLOAD ¥ VIA LOS LINK OR SATELLITE LINK ¥ DYNAMIC RETASKING OF SENSOR
IV. SENSOR & AIR VEHICLE CONTROL & DATA RECEIPT/USE	¥ LEVEL III FUNCTIONALITY plus ¥ MISSION REPLANNING ¥ AIR VEHICLE ROUTE PLANNING (WAYPOINTS, PRE-DEFINED PATTERNS) ¥ AIR VEHICLE FLIGHT CONTROL ¥ DYNAMIC RETASKING OF AIR VEHICLE
V. FULL UAV CONTROL - LAUNCH & RECOVERY	¥ LEVEL IV FUNCTIONALITY plus ¥ MISSION PLANNING ¥ MISSION MONITORING ¥ LAUNCH, RECOVERY, & LANDING

* From the UAV or its supporting satellite through the TCS datalink

Figure 3-1. Levels of Interaction/Functionality

3.3.1 Level I. TCS Level I interaction involves the receipt and display of UAV-derived product (imagery or data) without direct interaction with the UAV. Imagery and data are received through established communications channels or from connectivity with another TCS system. Level I also provides the capability for further product annotation and dissemination following initial receipt. Level I requires a TCS workstation or a compatible workstation to host TCS, and connectivity to an existing information dissemination network. UAV products can be received and disseminated through any C4I system with a TCS interface (see Section 3.7.2, C4I Interoperability). Since TCS Level I operations involve no interaction direct with the UAV providing the imagery, minimal TCS-specific training is required. TCS dedicated personnel are not required.

3.3.2 Level II. TCS Level II interaction involves the receipt and display of imagery and data directly from the air vehicle or its supporting satellite through the TCS datalink for that UAV without filtering or processing at another location. This requires a TCS workstation or a compatible workstation to host TCS and hardware necessary to interact with the air vehicle beyond that required for Level I operations. At a minimum, TCS Level II operations require air vehicle specific data link control modules (DCMs) and companion air vehicle specific ground data terminals (GDTs), and a compatible line-of-sight (LOS) or beyond line-of-sight (BLOS) antenna. DCM/GDT antenna hardware is required to receive imagery and telemetry direct from the UAV. In addition, a synthetic aperture radar (SAR) processor and a digital communications link, such as the tactical common data link (TCDL) or satellite communications (SATCOM), are required to receive and process SAR products from SAR equipped UAVs. Since Level II operations involve direct interaction with the UAV, TCS operator training requirements are more robust than for Level I and require more in depth knowledge of UAV operations and specific UAV capabilities and performance.

3.3.3 Level III. TCS Level III interaction involves control of the UAV payload separate from control of the air vehicle. In Level III operations, the actual flight of the air vehicle (AV) is accomplished from one control node (i.e., dedicated GCS or another TCS) while the payload is controlled from a different TCS node. For example, in a shipboard environment the AV control workstation could be located in one location and the sensor control workstation located in another; in this case, sensor control is exercised separately from AV control, but both control uplink and downlink signals share a single datalink. **To allow for simultaneous payload and AV control from two geographically separated control nodes, two separate up-link signals are required.** TCS Level III operations have the same hardware requirements as Level II. Level III control requires additional operator training and operators qualified and current in payload control operations.

3.3.4 Level IV. TCS Level IV interaction involves control of the air vehicle. Level IV operations have essentially the same hardware requirements as Level II and III. Level IV functionality is enabled through the activation of air vehicle control applications in the TCS software. Level IV may require the TCS system to have additional hardware (e.g., joystick, pedals, throttle, or touch screen, as necessary) to provide both manual and automated air vehicle control. Accordingly, TCS can incorporate a suite of hardware controls that replicate the functionality of legacy UAV manual controls. Through specific software application, TCS manual air vehicle controls can be dynamically reconfigured to meet the manual control requirements of current UAV systems. Level IV operations require appropriate operator training in the flight of specific air vehicles. Air vehicle operators must be trained, qualified, proficient, and current in accordance with the operating Service s training and operations regulations for the AV being flown.

3.3.5 Level V. TCS Level V interaction involves full function and control of the UAV to include take-off and landing. Level V operations have the same hardware requirements as Levels II-IV plus any unique launch and recovery equipment with the added requirement for an automated takeoff and landing capability. The automated system may be a system such as the UAV Common Automated Recovery System (CARS) which is a microwave based system or through a differential GPS system such as the Integrity Beacon Landing System (IBLS). Level V operations require appropriate operator training in the flight operations for specific air vehicles. Air vehicle operators must be trained, qualified, proficient, and current in accordance with the operating Service s training and operations regulations for the AV being flown.

3.4 SYSTEM COMPONENTS. The TCS system is functionally and physically partitioned into hardware and software components to provide an open architecture that supports efficient fault isolation and has the following characteristics:

- Complies with the Joint Technical Architecture (JTA).
- Uses DII/COE to the maximum extent practical.
- Maximizes common TCS hardware and software to support different AVs and payloads.
- Provides maximum commonality between TCS configurations.
- Minimizes UAV flight critical hardware and software.
- Minimizes effect of UAV and payload modifications and upgrades on the TCS system.
- Minimizes the impact of C4I system upgrades and modifications to the system.
- Minimizes the integration efforts to control additional air vehicle and payload types.

3.4.1 TCS System/Subsystem. The TCS system consists of a number of subsystems that are comprised of hardware and software components. The subsystems that comprise a complete TCS system include the AV communications subsystem, the launch and recovery subsystem, the real time subsystem, the payload subsystem, the operator station subsystem, the communications subsystem, and the power distribution subsystem. In addition, each TCS system will also have certain configuration dependent subsystem equipment. Figure 3-2 shows the TCS subsystems and the hardware and software configuration items within each subsystem. See Appendix D for a detailed description of hardware, software, and other component functionality.

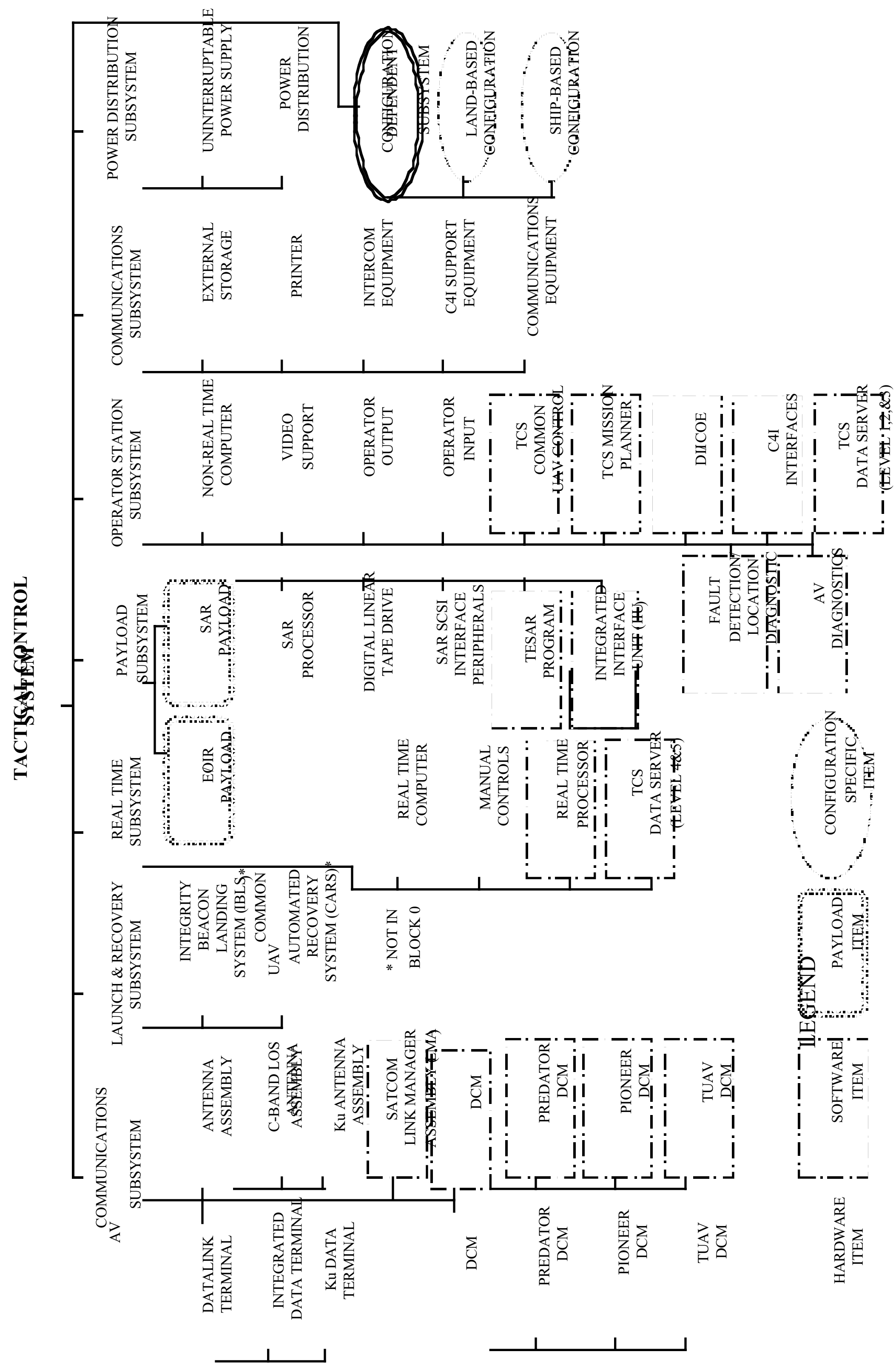

Figure 3-2. TCS System/Subsystems

3.4.2 System Architecture. The variety of hardware and software components that comprise the TCS system/subsystems are architecturally interfaced through hardware-to-hardware, software-to-software, and software-to-hardware interfaces to achieve TCS functionality. Figure 3-3 shows the component architecture of a UAV system with TCS.

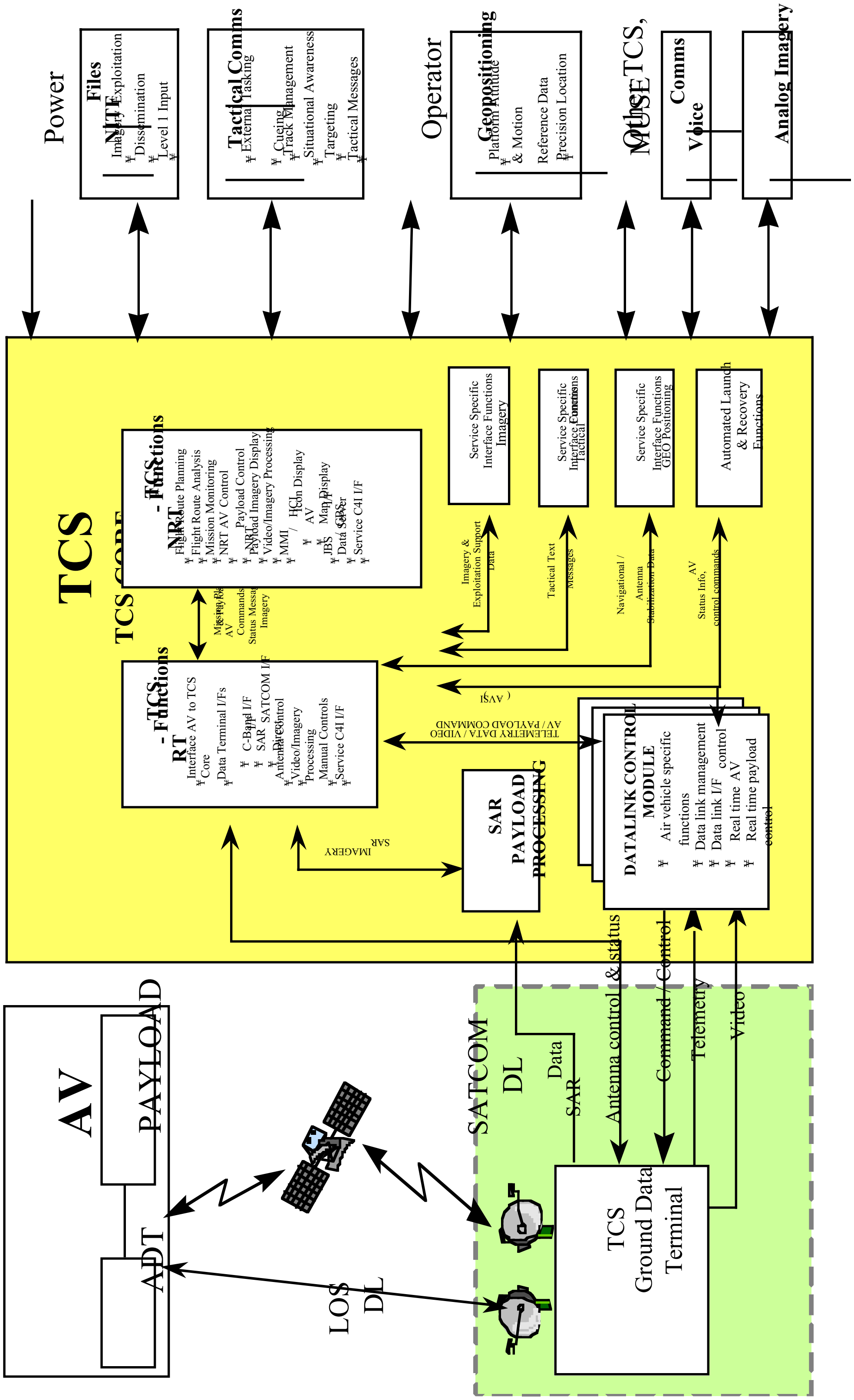

Figure 3-3. TCS Component Architecture

3.5 SYSTEM OPERATION. TCS operates on a set of core functions common to all UAVs that are required for fundamental operations. These core functions include mission planning, mission control and monitoring, data link monitoring and operator-computer interface. TCS is segregated into three principal segments: real time, non real-time, and AV specific. The real-time segment includes those flight critical interfaces and processes to command and control the air vehicle and data link. The non-real-time interfaces include mission planning, operator input/output, and message handling functions. The air vehicle standard interface (AVSI) is flight and mission critical, and enables the data server software to interface with AV specific DCM hardware. As such it also provides the real-time gateway between the DCM and the non-real time portions of TCS. This feature allows each UAV manufacturer s DCM to retain its proprietary air vehicle unique commands and system controls while enabling operations on the TCS network with core functions.

Until the advent of TCDL which will allow a single wide band antenna to transmit and receive multiple UAV commands, each UAV requires its own unique datalink and antenna assemblies. Therefore TCS must currently be configured with multiple GDTs and antennas to control different types of air vehicles. Specific GDTs are required to synchronize the ground station signal with that of the air vehicle data link terminal (ADT).

TCS operates primarily by internally and externally interfacing hardware and software to achieve the functionality of a specific configuration. Internal interfaces support interaction between the various hardware and software components of the system/subsystems. External interfaces involve inputs and outputs between TCS and supporting equipment. See Appendix D for a more detailed discussion of TCS component interfaces.

TCS has three run states: Startup, Operations, and Shutdown. The Startup state applies power to equipment and activates hardware and software components necessary to run the operations state. The Operations state requires all hardware and software components be ready to accept and process commands. The Operations state consists of two substates; Operational and Maintenance. The Shutdown state allows commands from the TCS operator to halt equipment in preparation for shutdown. TCS states and substates are mutually exclusive. Figure 3-4 shows TCS run states and user access to those states.

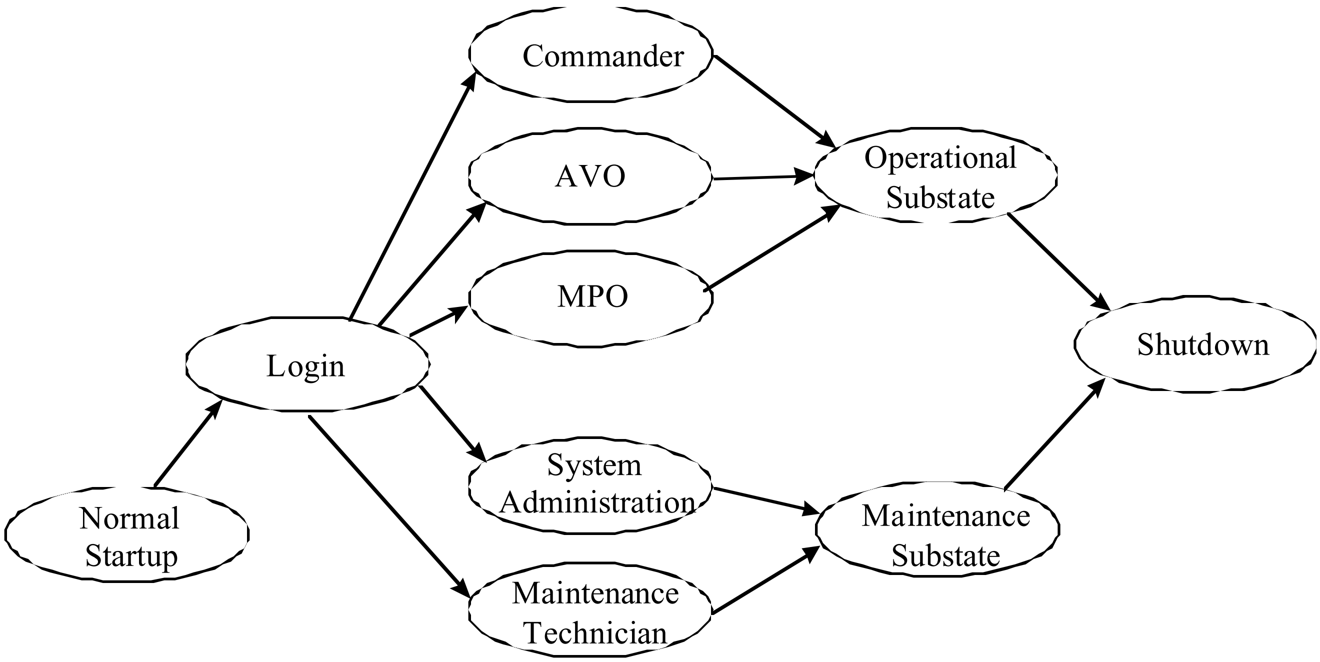

Figure 3-4 TCS Run States and User Access

Various functionality is provided for each run state and sub-state and is based upon the requirements associated with that state/sub-state. Within the Operations state, functionality is provided by assignment to one or more TCS user roles within the Operational or Maintenance sub-states as shown in Figure 3-5.

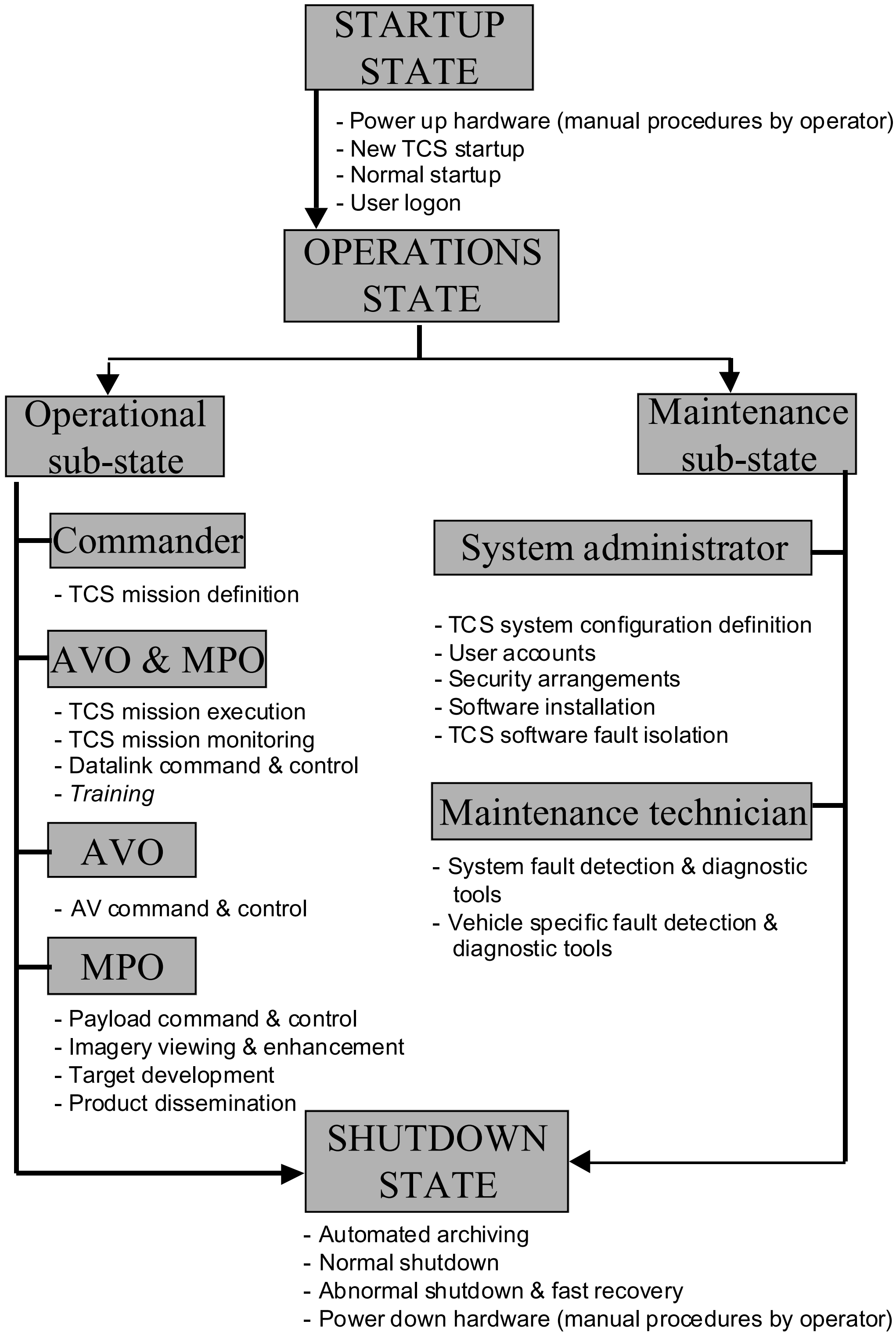

Figure 3-5. TCS States Functionality

3.6 CONFIGURATION. TCS functionality is available in three system configurations: an LB HMMWV-shelter production version, a SB ship-based version, and an RQ-1A system GCS version. *Exact configuration of production TCS system versions will be determined based upon the assessment of operational suitability during DT/OT with engineering development unit (EDU) systems.*

TCS configurations are scalable and modular to enable upgrading or downgrading capability across the different levels of interaction. Options include LOS or BLOS control, single or multiple payload or air vehicle control, EO/IR or SAR imagery processing, and single or multiple TCS workstations. A typical UAV GCS with TCS capability consists of two workstations (a Mission Payload Operator [MPO] and an Air Vehicle Operator [AVO]), associated peripherals, dedicated UAV DCMs, dedicated UAV GDT, and associated hardware. Each workstation is functionally identical and hosts the image and data displays, route planner, and payload and vehicle controls. This provides full functionality at all levels of interaction to be accomplished from a single TCS workstation. Configurations differ as specific functionality is added or removed. Level I configurations require a minimum of hardware and software components while Level II through V configurations require air vehicle related hardware (DCMs/GDT) to allow TCS — air vehicle interaction.

3.6.1 Land-Based (LB) Configuration. The notional LB TCS configuration is incorporated into a HMMWV-mounted shelter and includes two crew-oriented, independently functioning and interoperable TCS workstations, associated peripherals, DCMs, GDT, and antennas. TCS software is hosted on Sun tactical computers and is fully interoperable with the operating Service tactical C4I system. The land-based TCS configuration will be deployed by Army in their TUAV system and by Marine Corps in their VTUAV system. This configuration is fully transportable to the operating area by air, rail, or sea, and is self-mobile once on the ground. The land-based configuration requires 1 hour to set-up and _ hour to teardown. Figure 3-6 shows a representative LB configuration.

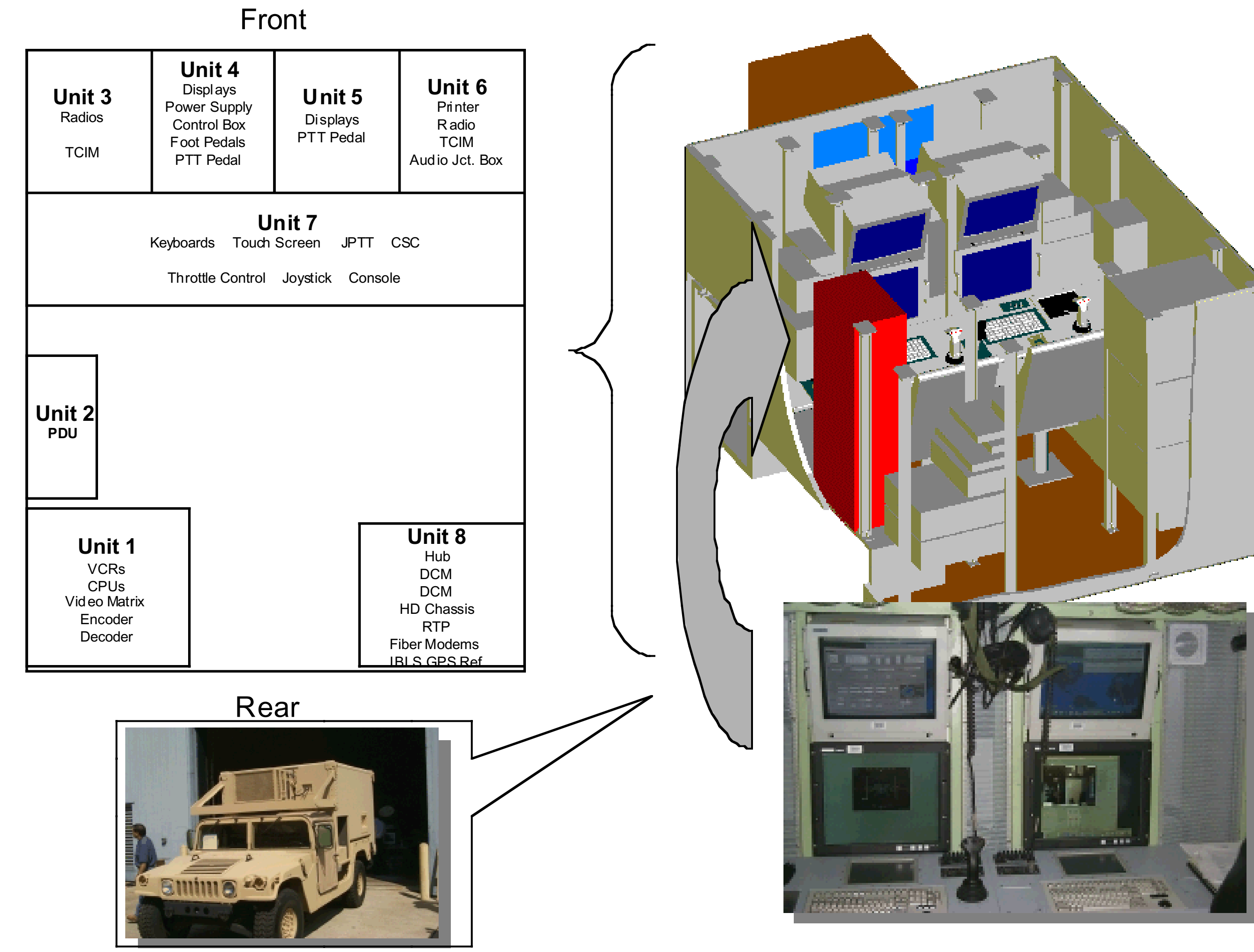

Figure 3-6. TCS Land-Based HMMWV Shelter Configuration

3.6.2 Sea-Based (SB) Configuration. The SB TCS configuration can be incorporated into ships that have undergone the approved TCS ship alteration to install system cabling and antenna(s), and have adequate space to accommodate required TCS components. The notional SB configuration consists of two workstations, associated peripherals, DCMs, GDT, and antenna(s). The sea-based TCS configuration is hosted on TAC-X series computers and is fully interoperable with the shipboard Joint Maritime Command Information System (JMCIS). In the SB configuration, antenna location, polarization, and stabilization are key to successful operations. Most single antenna installations will result in signal blockage as the ship s superstructure masks the signal between the air vehicle and the data link antenna at certain times. In addition, a two antenna installation is required to provide simultaneous multiple UAV control capability. Figure 3-7 shows a notional SB Level IV or V system configuration with LOS and BLOS capability.

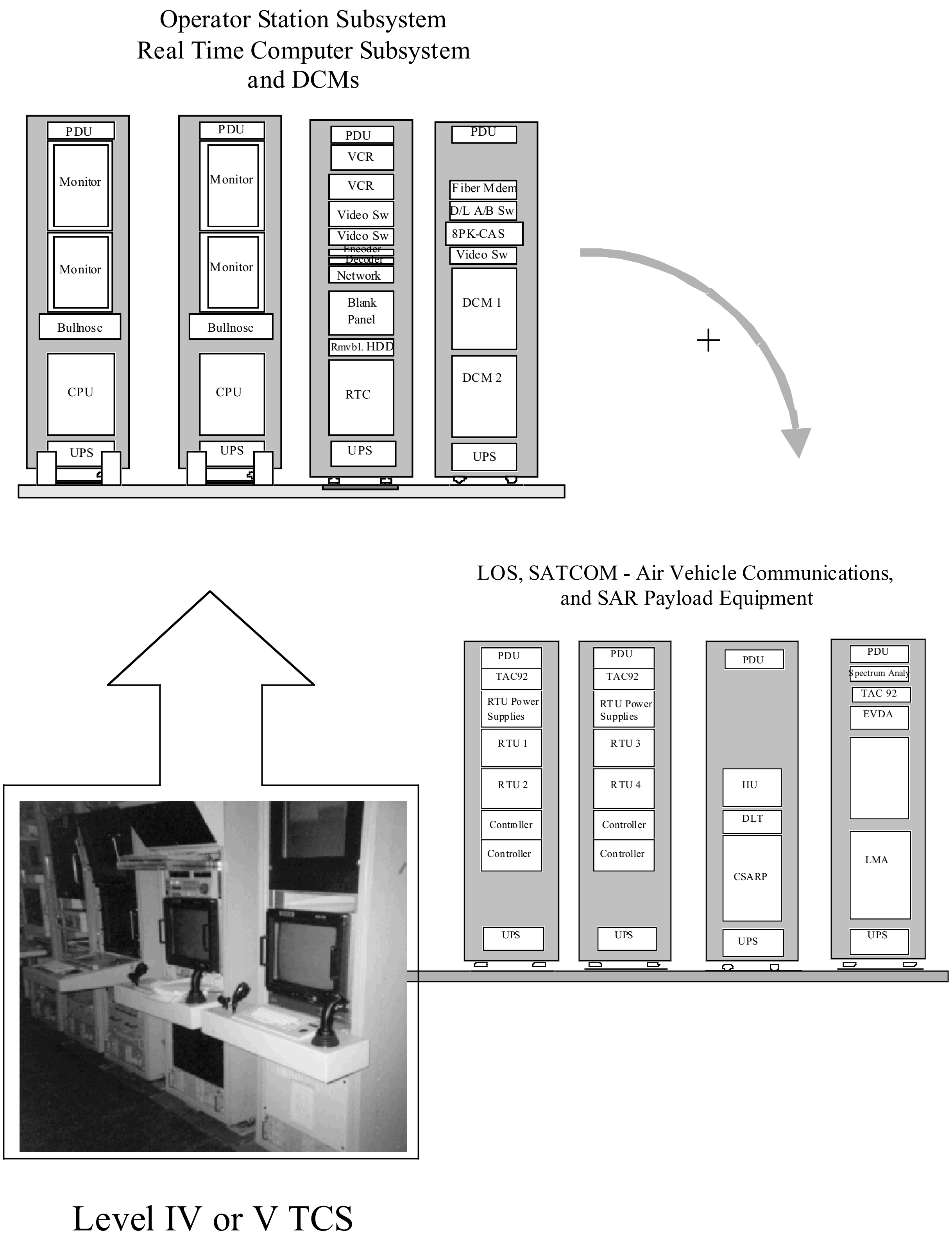

Figure 3-7. TCS Sea-Based Configuration

3.6.3 RQ-1A MAE UAV GCS Configuration. RQ-1A GCSs will be modified with TCS software to achieve DII/COE compliance and provide TCS interoperability. This modification facilitates the dissemination of RQ-1A Predator-derived imagery and data to other TCS nodes or specified joint or Service C4I systems through a GCS-TCS-C4I system interface. It also provides the RQ-1A GCS the capability to receive other UAV-derived products. Air Force Predator systems, however, have no requirement to control either the sensor or AV of other Service tactical UAVs; therefore, a TCS modified RQ-1A GCS will not provide that operational capability.

3.7 TCS INTEROPERABILITY. The JROC requirement is for TCS to be interoperable up to and including Level IV with the Predator MAE UAV and interoperable up to and including Level V with tactical UAVs (TUAVs) and future MAE UAVs. Interoperability is required with joint and Service C4I systems and also with HAE UAV for imagery receipt as an objective capability. Open software architecture supports future UAV interoperability by establishing standards, interfaces, and protocols for air vehicle operation and imagery dissemination. TCS is also capable of supporting additional software modules for future payloads and payload capabilities (e.g., autosearch and automatic target tracking) for current UAV systems.

3.7.1 UAV Interoperability.

3.7.1.1 Tactical UAV Interoperability. Army, Navy, and Marine Corps TCS systems will be functionally interoperable at Levels I through V with their organic tactical UAV system and all future tactical UAVs. Air Force RQ-1A GCS systems will not be interoperable at any level of TCS functionality with tactical UAVs.

3.7.1.2 RQ-1A PREDATOR MAE UAV Interoperability. Army, Navy, and Marine Corps TCS systems will be functionally interoperable at Levels I through IV with the RQ-1A Predator MAE UAV. The Air Force RQ-1A GCS will be functionally interoperable through TCS with the RQ-1A Predator MAE UAV for Level I C4I interface to disseminate Predator imagery received from the Predator GCS.

Note: Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.

3.7.1.3 HAE UAV Interoperability. All Services TCS systems will be functionally interoperable with the Global Hawk HAE UAV as an objective capability to receive HAE imagery. Individual Service TCS system interoperability at Level I or II with the HAE UAV is to be determined. Army is pursuing Level III and IV interoperability in selected non-UAV system equipment including the Enhanced Tactical Radar Correlator (ETRAC), Tactical Exploitation System (TES), and the GUARDRAIL Integrated Processing Facility (IPF)/Aerial Common Sensor (ACS) Ground Processing Facility. Navy is identifying Level III and IV interoperability as an objective requirement.

3.7.2 C4I Interoperability. TCS is interoperable with selected joint, Service, and NATO C4I systems. This interoperability facilitates the dissemination of imagery and data at all levels of interaction and eliminates the requirement for individual UAV systems to develop interfaces with the myriad C4I systems. The TCS system and individual workstations are capable of receiving, displaying, and transmitting a complete complement of imagery types including still, motion, and video.

Additional communications bandwidth and components, driven by the type of products and timeliness required by the user, are required to enable real time connectivity with other nodes. Near real time full motion video and SAR frame imagery receipt and dissemination impose the greatest requirement and will necessitate a minimum of a T-1 capable circuit. BLOS operations may require a large earth terminal for direct receipt of the product.

The capability of TCS to receive imagery from a UAV can be constrained by the capabilities of the communications path providing the imagery to the TCS system. The capability to further disseminate the received imagery is a function of the physical hardware and software capabilities of the C4I system to which TCS is interfaced. In addition, JFC or Service component commander priorities for imagery dissemination may artificially limit the complete use of those capabilities. Physical limitations affecting TCS/C4I interoperability with respect to specific system processing capabilities for image size, frame rate, transmission speed, compression techniques employed, and bandwidth availability for imagery dissemination are standardized by DII/COE.

TCS integration with C4I systems is accomplished through interfaces that permit information exchange between the TCS and the specified C4I systems. Figure 3-8 shows the various C4I systems with which TCS is interoperable (see Appendix G for system names associated with the acronyms). In addition, TCS interfaces with standard DoD tactical (very high frequency [VHF], ultra-high frequency [UHF], VHF/UHF, and high frequency [HF]) radios, Mobile Subscriber Equipment (MSE), and military and civilian satellite communications.

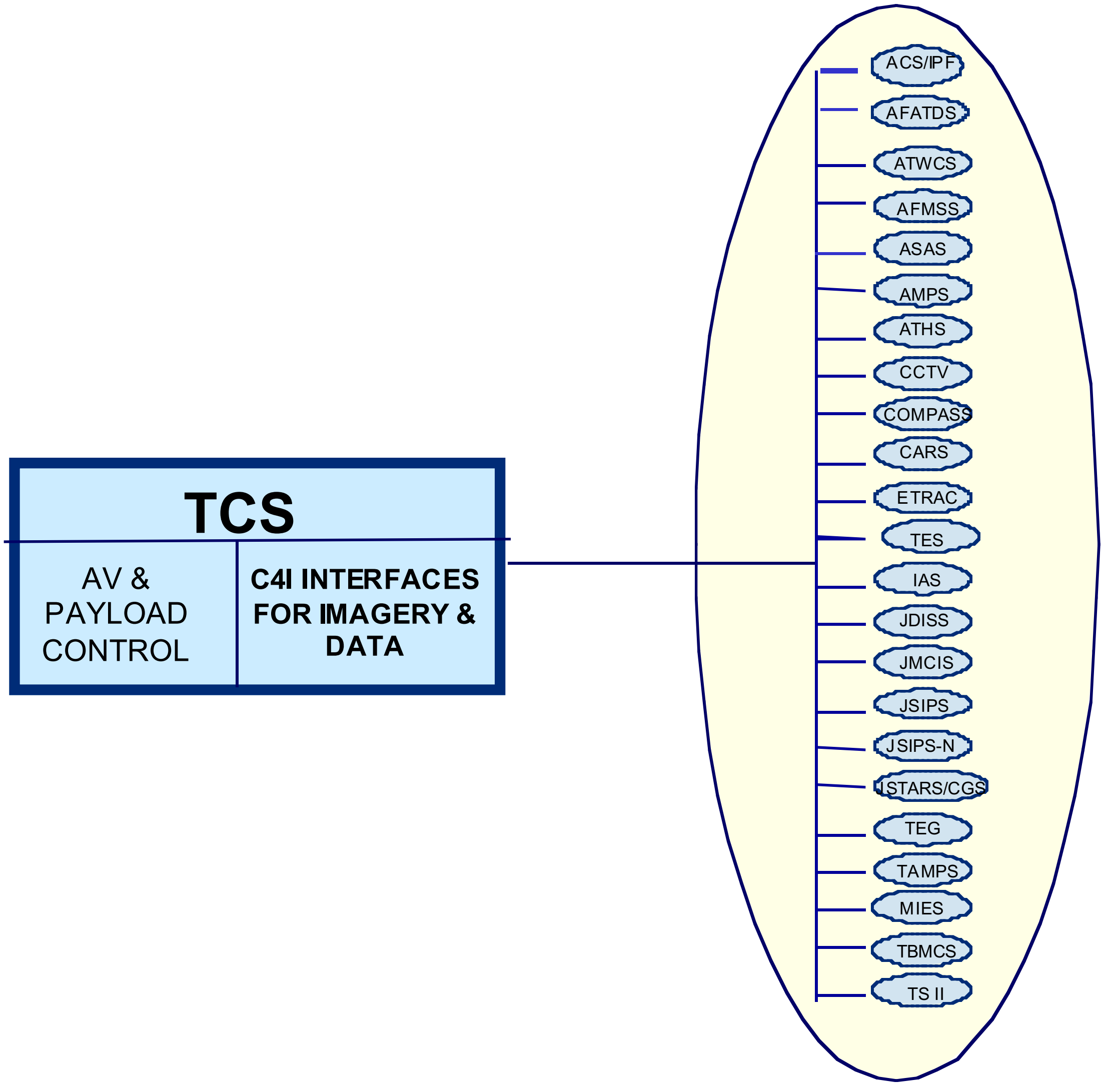

Figure 3-8. TCS-C4I Interoperability

3.8 TCS PERFORMANCE AND LIMITATIONS.

3.8.1 Performance Parameters. TCS is designed to the following performance standards:

- Operating continuously in the Operation Mode for a minimum of 72 hours.
- An operating availability rate of 90%.
- After emplacement at the operational site, planning and conducting a mission within 1 hour of tasking, to include planning a mission with a minimum of one waypoint, preparing two AVs for flight, setting up a data-link terminal, installing safety equipment, and launching a single AV.
- A mean-time-between-failure (MTBF) equal to or greater than 250 hours (objective).
- A mean-time-to-repair (MTTR) of equal to or less than 1.9 hours.
- Requiring less than one hour per day of preventative maintenance (PM) on a non-interference basis and less than one hour per week on an interference basis.
- Storing 640 column by 480 row 24-bit RGB color still frame images using a hard drive of greater than or equal to 9.0 gigabytes. Images may be stored in either uncompressed format (approximately 922 Kb) or in JPEG compressed format (approximately 50-53 Kb at 16:1 compression ratio). Image sizes include metadata associated with the image.
- The uninterruptable power supply (UPS) is capable of supplying 30 minutes of power to flight critical components.

3.8.2 System Reliability. TCS hardware has the following MTBF reliability values:

Datalink Control Module	1000 hours
Real Time Computer	2500 hours
SAR system	2500 hours
Link Manager Assembly	1667 hours
Non-Real Time Computer 1	1667 hours
Non-Real Time Computer 2	1667 hours
Video support	2500 hours
Printer	3000 hours
Intercom Equipment	5000 hours
C4I Support Equipment	9333 hours
UPS	568 hours
Power Distribution	2500 hours

3.8.2 System Limitations. TCS is capable of operating indefinitely with the availability of spares and trained personnel although stated TCS performance parameters (MTBF, A_o, etc.) may be less than some systems with which it is interoperable (e.g. RQ-1A Predator and Global Hawk are both designed to operate 24 hours per day/7 days per week). Differences in design performance may impose some potential system operating limitations.

4.0 TCS EMPLOYMENT AND OPERATIONS

4.1 PURPOSE. This section provides background information and broad guidance concerning the employment and operation of TCS. Emphasis is at the JFC and Service and functional component commander levels. Information and guidance contained herein is intentionally descriptive in nature rather than prescriptive so as to provide all commanders with the greatest flexibility in determining how best to employ TCS capabilities to achieve maximum combat capability across the range of military operations.

The general concepts presented in Section 4.3, General Employment Concepts, provide a framework and guide for operational employment of TCS capabilities. Section 4.4, Specific Employment Concepts, provides the potential TCS user with representative applications of TCS capability in a variety of scenarios across the military operations continuum. When combined with the notional concepts presented in Section 4.3, the representative applications provide a baseline from which UAV command and control (C2) employment and imagery dissemination options may be considered and decisions regarding specific applications of TCS may be made.

4.2 OVERVIEW. TCS contributes to the conduct of military operations within the framework of JV 2010 principles. The contribution of TCS is embodied in the fundamental capabilities the system brings to the battlespace. These capabilities provide the warfighter with enhanced functionality and flexibility in two areas: 1) payload and air vehicle command and control, and 2) imagery routing and dissemination. The common UAV command and control hardware and software suite TCS provides to the force gives commanders increased flexibility in establishing supported-supporting relationships among forces with or without organic UAV capability. The range of potential imagery dissemination interfaces and paths also provides commanders with new opportunities to furnish a wider range of recipients with information that will contribute to achieving joint warfighting goals.

In combination, endurance UAVs (EUAVs) and tactical UAVs are valuable assets that can assist a joint force in meeting a variety of theater, operational, and tactical objectives. UAVs are force multipliers. They can be used to conduct day or night RSTA tasks, facilitate battle damage assessment (BDA), and contribute to force asset management. UAVs are particularly useful where human safety is a prime factor, the availability of manned systems is limited, or loss of high-value, manned systems is possible, and real-time or near-real-time information is required. Current and planned near term UAV force structure means UAVs are low density, high demand (LDHD) resources. In order to create the necessary synergy and optimize the employment of these LDHD resources, the JFC must ensure the actions of assigned, attached, and supporting UAV capabilities/forces are synchronized in time, space, and purpose. To achieve assigned objectives as rapidly and effectively as possible, the JFC must also fully exploit the unique capability of TCS to interoperate with the families of all UAVs and interface with the full range of C4I systems available.

TCS allows UAVs to be fully integrated as either a component of or to augment various weapons systems throughout the battlespace. The unique capability of UAVs to loiter for long periods and deliver real time sensor information provides a level of utility well above and beyond traditional reconnaissance and surveillance activities. More pointedly, in cases where the warfighter is engaged with the enemy there is need for dedicated real time information and tactical control of the source of that information. In these situations there is no need, nor is there time for the information to pass through an analysis filter, or for warfighter verbal communications with a distant UAV control node. In such cases, the warfighter can benefit from having control of UAV payloads that are, by and large, less sophisticated than the weapon systems the forces are currently employing to engage the enemy.

Accordingly, employment planning and tasking of TCS capabilities to support joint force objectives will be centralized within existing joint force organizations and processes. To accomplish TCS employment planning, tasking, and execution at the joint force level, the JFC will define supported-supporting relationships among staff organizations, and functional and Service component commanders.

Employment planning, tasking, and dynamic retasking of UAVs in support of the JFC, or other components, are centralized functions to be performed by organization(s) designated by the JFC. Centralizing these functions ensures the necessary synergy to coordinate required collection management processes, apportion the joint air effort, and develop the joint air operations plan. This ensures unity of effort in the planning and tasking of UAVs to the benefit of the joint force as a whole. Embedded within that function, the unique UAV C2 interfaces and dissemination capabilities the TCS system provides to the force will also be planned and tasked. The organization(s) designated by the JFC to perform these functions will be guided by JFC objectives and the commander s intent regarding employment of EUAV and TUAV assets to interchangeably support the full range of objectives from tactical to theater level.

During planning for the employment of UAVs, conflicts may develop between Service doctrine or UAV employment concepts and procedures, and concepts and procedures available from the enhanced capabilities of TCS. When such conflicts are identified, they will be resolved on a case-by-case basis between the JFC and the Service component operational control (OPCON) authority.

4.3 GENERAL EMPLOYMENT CONCEPTS. The fully scalable and flexible nature of TCS offers joint force commanders a wide range of options to integrate TCS capabilities into the joint air operations plan and to fulfill forcewide UAV collection and dissemination requirements. TCS employment options are companion considerations in the development of the UAV C2 and payload employment strategy, and the plan for dissemination of UAV products to the warfighter.

When, and exactly how to employ the unique TCS UAV C2 and imagery dissemination capabilities will be a function of specific TCS configurations, available TCS nodes, user requirements, and the operator training, qualification and currency needed to employ the desired level of functionality. The range of TCS functionality is shown in Figure 4-1.

¥ RECEIVE & DISSEMINATE ANALOG VIDEO & NITF DIGITAL IMAGERY
¥ CONDUCT VOICE COMMUNICATIONS FOR AIRSPACE CONTROL & INTERFACE FOR TACTICAL VOICE COMMUNICATIONS
¥ FORMAT, TRANSMIT, & RECEIVE SELECTED TACTICAL COMMUNICATIONS MESSAGES
¥ RECORD & RETRIEVE PAYLOAD DATA
¥ VIEW & REVIEW* PAYLOAD DATA FROM MULTIPLE PAYLOADS SIMULTANEOUSLY
¥ CONTROL & MONITOR MULTIPLE PAYLOADS SIMULTANEOUSLY
¥ PLAN UAV MISSIONS
¥ CONTROL & MONITOR MULTIPLE UAVs SIMULTANEOUSLY
¥ MONITOR THE PERFORMANCE & STATUS OF THE UAV SYSTEM

Figure 4-1. TCS Functionality

* UAV imagery review capability varies by Service component —

Air Force —	Air Force capability (within the RQ-1A GCS) involves first look analysis and voice reports.
Army —	Army capability varies by echelon. Lower echelons provide less detailed analysis with text reports.
Marine Corps —	Marine Corps capability provides limited exploitation and comparative analysis
Navy —	Navy capability provides first look exploitation and voice reports.

Specific training is required to effectively employ TCS (see Appendix E). With the appropriate TCS and Service specific air vehicle/payload training, Service operator and maintenance personnel should be capable of fully employing TCS at all five levels of functionality. In addition, with the appropriate TCS and necessary UAV functional training, personnel without specific air vehicle operator training should be capable of employing TCS at Levels I and II. For high tempo operations, it may be prudent to augment TCS-equipped, UAV units with additional TCS/air vehicle-qualified operator and maintenance personnel. During extended or high tempo operations, individual Service policy will dictate the optimum duty cycle for TCS operators.

4.3.1 TCS Organization. TCS capability will be integrated with all tactical UAV units and with the USAF RQ-1A MAE UAV system. TCS capability could also be integrated into non-UAV units as determined by Service requirements and when directed by appropriate operational authority. Combatant command authority (COCOM), OPCON, tactical control authority (TACON), and administrative control (ADCON) of TCS is exercised through normal organizational command structures.

Geographic CINCs have COCOM of all Service component forces assigned under the Secretary of Defense (SECDEF) Forces For Unified Commands memorandum, including all TCS-capable tactical units. U.S. Joint Forces Command is also COCOM of all RQ-1A MAE UAV forces. OPCON and TACON of TCS-capable units will be exercised through respective JFCs and individual Service component commanders. ADCON of TCS-capable units is an individual Service component commander responsibility.

4.3.1.1 COCOM Responsibilities. Combatant commanders exercising command authority over TCS-capable forces will employ them to meet their own theater operational and training needs, and will deploy TCS-capable forces to satisfy the operational and exercise requirements of other CINCs when the Joint Staff directs such support.

4.3.1.1.1 TCS Deployment. Operational deployment of TCS-capable units will be coordinated between the supported and supporting COCOM authorities. Inter-theater transportation for TCS-capable units with land-based or RQ-1A GCS TCS configurations will normally be by air; intra-theater transportation may be by ground, rail, or air. TCS installation aboard Navy ships is a complex and time-consuming operation. Therefore, TCS will be deployed on ships already outfitted and configured with TCS.

4.3.1.1.2 TCS-Capable Unit Basing. Unless specifically directed otherwise by the COCOM authority, basing of both UAV and TCS-capable non-UAV units (if established) will normally follow Service component command echelon plans.

4.3.1.2 OPCON Responsibilities. JFCs and Service component commanders exercise OPCON of assigned and attached TCS-capable units. OPCON responsibility includes providing housing, security, messing, health care, and supply support for TCS-capable units deployed in support of operational or exercise requirements. Service component OPCON responsibility also includes decision authority regarding employment of TCS-capable units in Service operations, exercises, and demonstrations.

As dictated by JFC objectives, and as tasked by the designated tasking authority, the OPCON authority also has responsibility to provide the required C4I connectivity to support TCS imagery processing, exploitation, and dissemination (PED). In addition, where non-organic TCS control of air vehicles or payloads is anticipated, the OPCON authority should provide the necessary communications path(s) to coordinate handoffs between TCS units.

4.3.1.3 TACON Responsibilities. Commanders of TCS-equipped units exercise TACON of assigned TCS assets. As directed in the Air Tasking Order (ATO), TCS-equipped units also exercise TACON of UAV air vehicles or payloads for specific missions for specific periods of time.

4.3.1.4 ADCON Responsibilities. Service component commanders exercise ADCON of TCS-capable units. TCS logistics support is an ADCON authority responsibility.

4.3.2 TCS Planning and Tasking. Intelligence, surveillance, and reconnaissance (ISR) **planning** involves the collection, processing, validation, and prioritization of ISR collection requirements. ISR **tasking** includes matching collection requirements with collection resources and collection dissemination paths. Centralized ISR planning and tasking optimizes the application of forcewide manned and unmanned ISR resources, lessens the likelihood that more than one sensor will be focused on the same target at the same time, and ensures designated echelons of the force receive ISR products in a timely fashion.

The current families of UAVs are key resources that can support the full range of theater, operational and tactical ISR requirements. Therefore, planning the employment of UAV capabilities to meet forcewide ISR requirements is best accomplished as an integral part of the joint force collection management (CM) process. As air assets, the tasking of UAV missions is best accomplished within the ATO process.

4.3.2.1 Joint Operations. The JFC is responsible for determining how to centralize planning and tasking functions within the force. In most situations, the JFC will designate the J2 CM staff to conduct the ISR planning function within the CM process and designate a Joint Force Air Component Commander (JFACC) to conduct the ISR tasking function using the ATO process. There may be some situations where designating a component to perform the ISR planning function is advantageous. If the JFC delegates ISR planning responsibility to a component organization, the JFC must establish the necessary supported-supporting relationships within the force to accomplish both routine planning and tasking, and dynamic retasking.

Because TCS is both a command and control node for UAVs and an imagery dissemination interface to C4I systems, proper TCS integration is critical to the overall ISR plan. Centralizing the planning and tasking of TCS equipped units within existing joint force CM and ATO structures and processes is therefore necessary to synchronize and integrate the unique capabilities of TCS-equipped units with other capabilities of the force. It also minimizes the management requirement to integrate this new capability. TCS employment planning and tasking is correctly part of the joint force CM and ATO process. The existing Daily Airborne Reconnaissance Surveillance (DARS) process, discussed in U.S. Joint Forces Command Collection Management TTP, provides a proven methodology for optimizing the use of UAVs.

The organization responsible for UAV/TCS planning and tasking will develop the plan for TCS unit employment. The employment plan development process is synchronized with the joint force ATO development process and ensures the required tasking information is provided to the JFACC Joint Air Operations Center (JAOC) in a timely fashion. This plan should consider the employment factors shown in Figure 4-2.

- NUMBER, TYPES, AND LOCATIONS OF UAVs AVAILABLE
- THEATER, OPERATIONAL, AND TACTICAL NEEDS FOR THOSE UAVs
- NUMBER, CONFIGURATION and LOCATION OF TCS SYSTEMS AVAILABLE
- C4I EXPLOITATION ARCHITECTURES AND CAPABILITIES AVAILABLE WITHIN THE FORCE
- FREQUENCY MANAGEMENT PRIORITIES (DATA, VOICE, ETC.) AND BANDWIDTH AVAILABILITY
  - ANTENNA (LOS/BLOS) FUNCTION AND MANAGEMENT*
- EXPLOITATION ASSETS AVAILABLE TO RECEIVE TCS DATA
- TCS OPERATOR QUALIFICATIONS/CURRENCY
- OPERATING ENVIRONMENT
- RULES OF ENGAGEMENT
- CONTROLLED NATIONAL AIRSPACE CONSIDERATIONS
- SERVICE DOCTRINE OF THE UNITS EXERCISING OPCON OF THE UAV(s)

Figure 4-2. UAV/TCS Employment Considerations

* In both land-based and sea-based applications, antenna blockage during critical segments of UAV flight or payload control evolutions could result in the loss of UAV data and possibly loss of the air vehicle. In the sea-based environment, antenna destabilization can also pose potential problems. Therefore, antenna function and management are key operational factors that must be considered in the planning process.

The UAV/TCS unit employment plan will be provided to the JFACC for mission coordination, airspace deconfliction with the Airspace Control Authority (ACA), assignment of protection assets if required, and incorporation into the daily ATO. TCS unit employment will be reflected in the ATO through the ISR special instructions (SPINS). The SPINS will reflect UAV TACON, launch and recovery units, the unit(s) to command and control the air vehicle, the unit(s) to command and control the payload, and time periods for air vehicle or payload control, and handoff locations and times. In addition, the most efficient UAV product dissemination method (architecture, technique, process, and path) to ensure the required user(s) receive the payload product must be identified. When one component s UAV resources will be used to support another component s requirements, component to component coordination is required to refine UAV-TCS mission details as stipulated in the SPINS.

To support the UAV/TCS planning and tasking process, liaison officers (LNOs) from all components equipped with UAV capability should be assigned to support the organization(s) designated by the JFC. These LNOs provide functional area and mission expertise to support the proper planning and tasking of their component s capabilities and to coordinate cross-component support requirements. They are also responsible for keeping both the planning and tasking authorities aware of their component s specific UAV and TCS unit locations, and equipment and personnel readiness. The designated planning and tasking organizations will be guided by the concepts discussed in this CONOPS and perform their functions in accordance with current theater TTP and Standard Operating Procedures (SOP) for CM and ISR planning and tasking. The UAV/TCS planning and tasking process is shown in Figure 4-3.

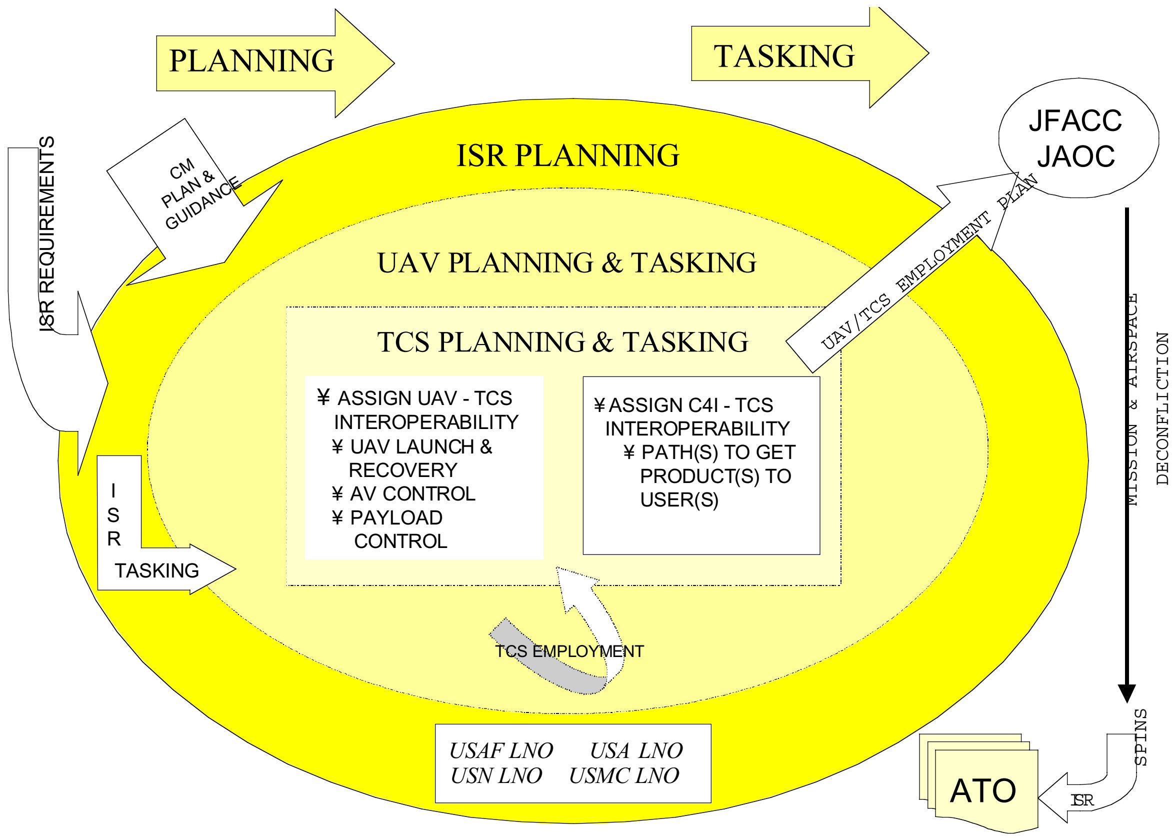

Figure 4-3. UAV/TCS Planning and Tasking Process

To ensure the entire force has the most complete awareness of forcewide ISR tasking, component collection requirements that will be accomplished with organic resources should be identified during the ISR planning and tasking process. Organic UAV missions that will fill these requirements should have mission plans provided to the JFACC to ensure air vehicles are properly protected, airspace is assigned and deconflicted, and the UAV missions are identified to all airspace users.

After the ATO is published, or missions are in execution, emergent ISR requirements will follow one of two planning and tasking paths.

- When sensor retasking alone can fill the requirement, the component with the requirement can coordinate directly with the respective UAV TACON authority to adjust the sensor plan (including TCS payload control assignments) and to coordinate and assign new tasking. If adjusting the approved sensor plan will impact other portions of the plan, then the JFC collection management authority (CMA) must establish sensor priorities. If the ATO plan will not be impacted by the adjustment, then the JFC CMA and JFACC should be informed once coordination has been completed.

- When a change of UAV mission profile is required to fill the emergent requirement, the component with the requirement must coordinate with both the UAV TACON authority and the JFACC to assess the impact and feasibility of changing the UAV mission profile and then advise the JFC CMA. If a change of mission profile (including TCS payload or AV control assignments) is feasible and warranted, the JFACC will coordinate and issue a change to the ATO for missions not yet in execution. Missions in execution will be dynamically retasked as coordinated by the JFACC.

Note: The capability for commanders to receive direct downlink of UAV sensor products will raise the level of expectation and result in an increase in dynamic mission changes. Current collection, asset, and mission management systems will be stressed to handle this increased load in a timely and efficient manner.

4.3.2.2 Single Service Operations. For single Service operations employing multiple TCSs, UAV planning and tasking will be accomplished in accordance with Service doctrine. In single Service operations, the responsible ACA will be provided UAV flight plans and will coordinate them with other flights in the area of operations. In operations where coordination is required with national airspace authorities, the UAV launch and recovery unit will normally be designated by higher authority to conduct that coordination.

4.3.3 Service Employment Concepts. When assigned to a joint force or attached to support a joint operation, TCS equipped Service components will conduct UAV operations under the direction of the JFC and in accordance with Service SOP. The efficient utilization of TCS brings operational enhancements to the employment of UAVs and enhances Service warfighter effectiveness in the conduct of joint military operations. Individual Service components may employ TCS in different ways and extract unique benefits in support of mission objectives.

4.3.3.1 Air Force. Air Force currently operates the RQ-1A Predator MAE UAV system to support national, theater, and operational tasks as directed by theater CINCs.

TCS interoperability provides the capability to expand RQ-1A Predator missions to support the tactical level of military operations by providing a direct delivery path for RQ-1A Predator imagery products to other component users and Service C4I systems. Such operations could involve RSTA tasks for deep strike operations or theater ballistic missile defense (TBMD), fire (naval gunfire, close air, etc.) support, maritime surface search and control, or amphibious landing support.

With the incorporation of TCS interoperability into the RQ-1A GCS, Air Force component forces are provided an avenue to disseminate Predator imagery directly to the different C4I systems with which TCS is interfaced. Additionally, TCS provides a direct electronic interface with the Service LNO at the designated planning and tasking authority. TCS can facilitate echelons below corps and other Service component support by providing communications connectivity between its distributed nodes, enabling faster request-approval-tasking loops and making imagery immediately available to the user.

4.3.3.2 Army. The Army will operate UAV systems to provide RSTA and battle management direct mission support to commanders at the Corps, Division, Armored Cavalry, and maneuver brigade echelons. Tactical UAVs will be used primarily as a confirming sensor, cued by other sensors or through the intelligence preparation of the battlefield (IPB) process. Tactical UAVs are capable of supporting the full range of RSTA functions based on the commander s priorities. The capabilities of these systems will be enhanced when they are employed as part of an overall collection plan and fully integrated with and cued by other intelligence collection systems, including other UAVs, in a synchronized effort.

TCS offers Army commanders the potential to integrate multiple tactical UAV and RQ-1A Predator ISR products in support of the ground maneuver commander s RSTA effort. TCS also provides the avenue for Army TUAV ISR products to be distributed to other Service components and elements of a joint force.

Army objectives require providing UAV payload data to a number of other systems to include the Joint Surveillance, Target Attack Radar System (JSTARS) Common Ground Segment (CGS). This can be accomplished by collocating TCS with CGS or by hosting TCS on the CGS workstation and providing the same data link receiver elements (a CGS objective requirement).

4.3.3.3 Marine Corps. The Marine Corps will use TCS to conduct VTUAV operations in support of expeditionary operations and to integrate UAV support to Marine Air-Ground Task Force (MAGTF) operations ashore and afloat. TCS will provide a means to control UAVs and disseminate UAV data to Aviation Combat Element (ACE)/Ground Combat Element (GCE) Commander(s), across a wide spectrum of operations, and provide a means to receive and disseminate data from non-organic UAV systems. TCS will allow properly trained personnel from other Services to operate Marine Corps VTUAVs in support of Operational Maneuver from the Sea/Amphibious Operations, while Marine and other landing forces are phasing ashore, providing RSTA/tactical coverage to commanders until shore facilities become operational.

TCS will support a variety of UAV operational and tactical tasks, afloat and ashore and maximize the effective ranges of Marine Corps weapons systems and aircraft.

4.3.3.4 Navy. The Navy will use TCS to employ organic VTUAVs and to integrate all UAVs in support of maritime and expeditionary RSTA functions. Navy receipt and dissemination of real time UAV data via TCS is critical in supporting a multitude of operations. Such operations could include strike warfare, communications/data relay, electronic warfare (EW), deep strike, naval surface fire support (NSFS), close air support (CAS); deep, shallow, and surf zone operations, and special operations conducted by Navy forces.

TCS will act as a force multiplier by providing scalable, direct and indirect UAV system control and data dissemination to all naval forces operationally capable of employing TCS. In addition, TCS provides naval forces the ability to use non-organic UAV assets to support all maritime operations out to the maximum effective ranges of naval weapons systems and aircraft.

TCS provides the means to diversify the methods by which UAVs are deployed/employed and enables the cross-decking of UAV systems (contingent upon installation of the necessary ship alteration [SHIPALT]) or embarkation of qualified Air Force or Army TCS operators to support UAV operations from selected naval ships. Navy also has rapidly deployable ashore facilities (Mobile Ashore Support Terminal (MAST) and Mobile Integrated Command Facility (MICFAC) with extensive C4I connectivity that could support TCS operations up to Level IV.

4.4 SPECIFIC EMPLOYMENT CONCEPTS. In its full configuration, TCS supports operations at five levels of increasing functionality. Those levels of operation, the flexibility with which TCS can be employed, and notional TCS employment considerations are discussed in the following paragraphs. The discussion of each level of operation is complemented with a **representative scenario to notionally demonstrate how that level of functionality might be employed**.

4.4.1 Level I Operations. Level I TCS operations involve the receipt and dissemination of UAV-derived imagery and data to a wide variety of users, totally independent of air vehicle or payload control requirements.

Level I TCS operations are characterized by passive receipt of UAV sensor products from a secondary source and are accomplished with no direct interaction between UAV and TCS. Level I also provides for further dissemination of UAV imagery if operationally required. Though any computer system properly configured and connected can receive imagery or data from a secondary source, TCS provides the air vehicle telemetry and image ephemeris data critical to image manipulation and processing.

4.4.1.1 Operational Considerations. Any TCS-equipped unit can conduct Level I operations. TCS Level I operations should be considered when the end user is not equipped or configured to receive data directly from the air vehicle. Also, the end user requires the product in a format that will allow more detailed imagery analysis. Level I TCS operations do not require external two-way voice communications.

4.4.1.1.1 Mission Planning. Level I TCS operations do not require detailed mission planning. Prior planning and coordination are required to ensure that the UAV product is disseminated to the proper user.

4.4.1.1.2 Handoff Procedures. Not applicable.

4.4.1.1.3 Personnel. Additional personnel are not required to support Level I TCS operations. There are no specific personnel specialty or sub-specialty codes associated with Level I operations.

4.4.1.1.4 Training/Qualification/Currency Standards. Level I TCS operations require minimal TCS related training. TCS operators require completion of the TCS Core course (see Appendix E). There are no unique currency standards for Level I operations.

4.4.1.2 Service Component Level I Capabilities. The following Service component forces/units will be capable of TCS operations at Level I:

Air Force:
- Air Operations Center (AOC)
- Wing Operations Center (WOC)
- Imagery Exploitation System (IES)
- UAV Exploitation System (UES)

Army: None
Marine Corps: None
Navy: None

Level I Representative Scenario
Preparation to conduct major joint military operation.
Mission: Conduct detailed intelligence preparation of the battlefield.

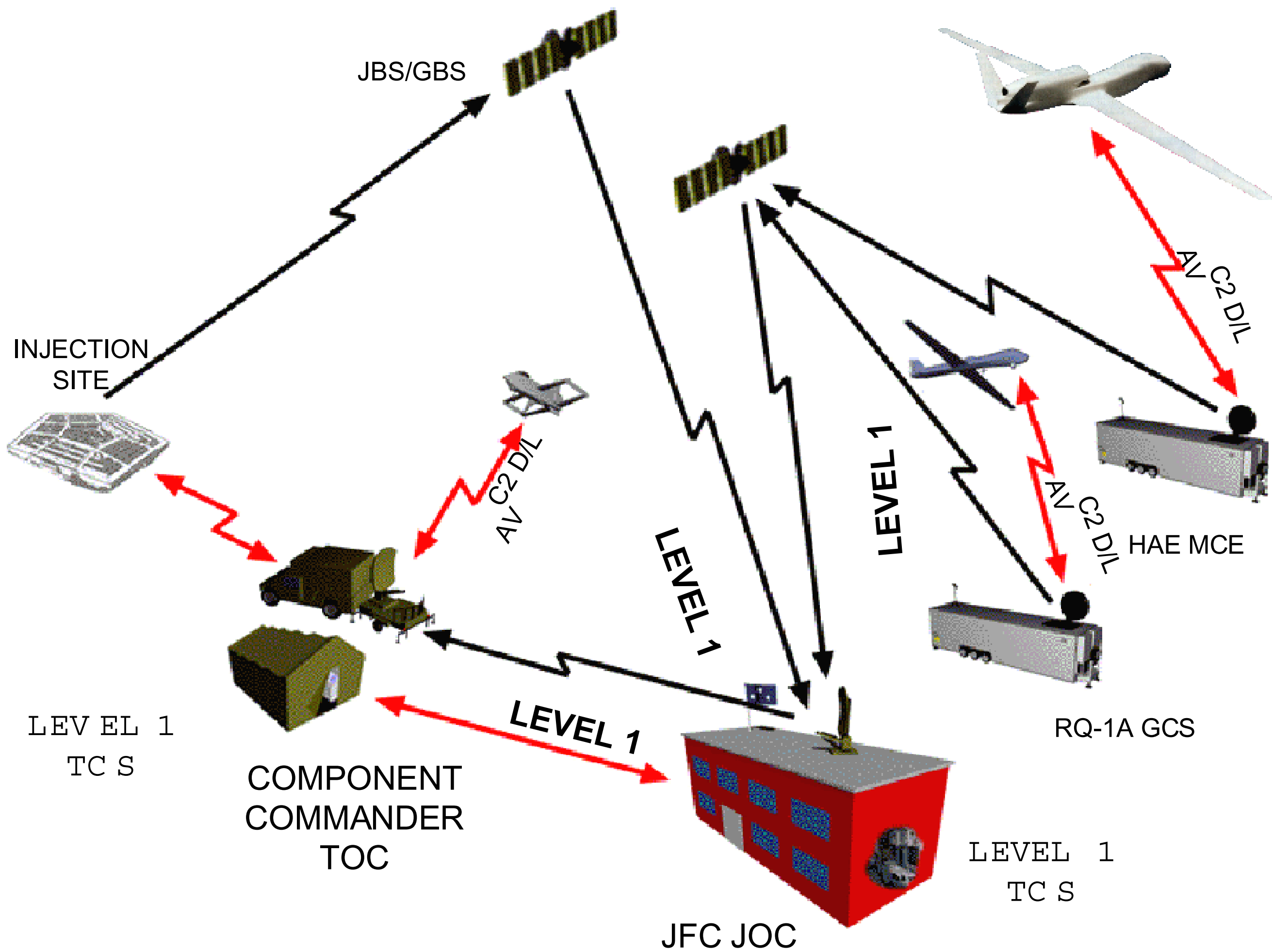

Figure 4-4. Level I TCS Operations

Level I TCS Employment Concept
JFC intent is to use assigned and attached UAV assets to conduct theater, operational, and tactical ISR missions to obtain imagery of the disposition of enemy forces and to maintain that picture until the start of hostilities. To achieve these objectives, Global Hawk HAE UAV missions are tasked to provide broad area SAR and electro-optical/infrared (EO/IR) imagery support and RQ-1A Predator missions are tasked to provide SAR imagery support of specific sites to the JFC Joint Operations Center (JOC). At the JFC JOC selected imagery is further disseminated to the ground component commander TOC. Tactical UAV assets are tasked to provide EO/IR imagery support to the ground component commander TOC, which further disseminates selected imagery to the JFC JOC. The JFC JOC and ground component commander TOC are both TCS capable and operating at Level I.

4.4.2 Level II Operations. Level II TCS operations, which may include Level I operations as well, involve receiving imagery and data directly (i.e., through the TCS datalink) from UAVs or their supporting satellite. Since the information is unfiltered and not processed at an intermediate location, Level II operations can speed the flow of information to units that need it most in a specific operation. This provides operational commanders with increased flexibility in planning UAV operations and in disseminating UAV products.

Level II operations should be considered when the end user is not capable of UAV payload or air vehicle control but requires the information in the most expeditious means possible. However, since the information is unfiltered, the receiving node must be capable of recognizing critical target details.

Level II TCS operations involve receipt of UAV sensor products through direct interaction between TCS workstations and UAVs or their supporting satellites. Level II TCS operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

4.4.2.1 Operational Considerations. Level II operations can be conducted LOS or BLOS and require antenna location within the downlink footprint of the UAV or its supporting satellite and a DCM/GDT capable of receiving and processing the downlink signal. Level II TCS operations do not require external two-way voice communications.

4.4.2.1.1 Mission Planning. Level II TCS operations may require preflight mission (AV or sensor) planning by the supported unit. Prior coordination is required to ensure the TCS user is within the downlink footprint at the specific time.

4.4.2.1.2 Handoff Procedures. Not applicable.

4.4.2.1.3 Personnel. Additional personnel are not required to support Level II TCS operations. However, personnel must be trained and able to operate the data link and interpret data and recognize key essential elements of information (EEI).

4.4.2.1.4 Training/Qualification/Currency Standards. Level II TCS operations require minimal TCS related training. TCS operators require completion of the TCS Core course (see Appendix E). There are no unique currency standards for Level II operations.

4.4.2.2 Service Component Level II Capabilities. The following Service component forces/units will be capable of TCS operations Level II and below:

- <u>Air Force:</u> None
- <u>Army:</u>
  - Army
  - Special Operations Forces (SOF)
- <u>Marine Corps:</u> None
- <u>Navy:</u> None

Level II Representative Scenario

Joint non-combatant evacuation operation (NEO) in a potentially non-permissive environment. Mission: Utilize a joint task force to conduct helicopter evacuation of US citizens and key foreign nationals from a designated airfield. Provide perimeter protection throughout the evacuation process.

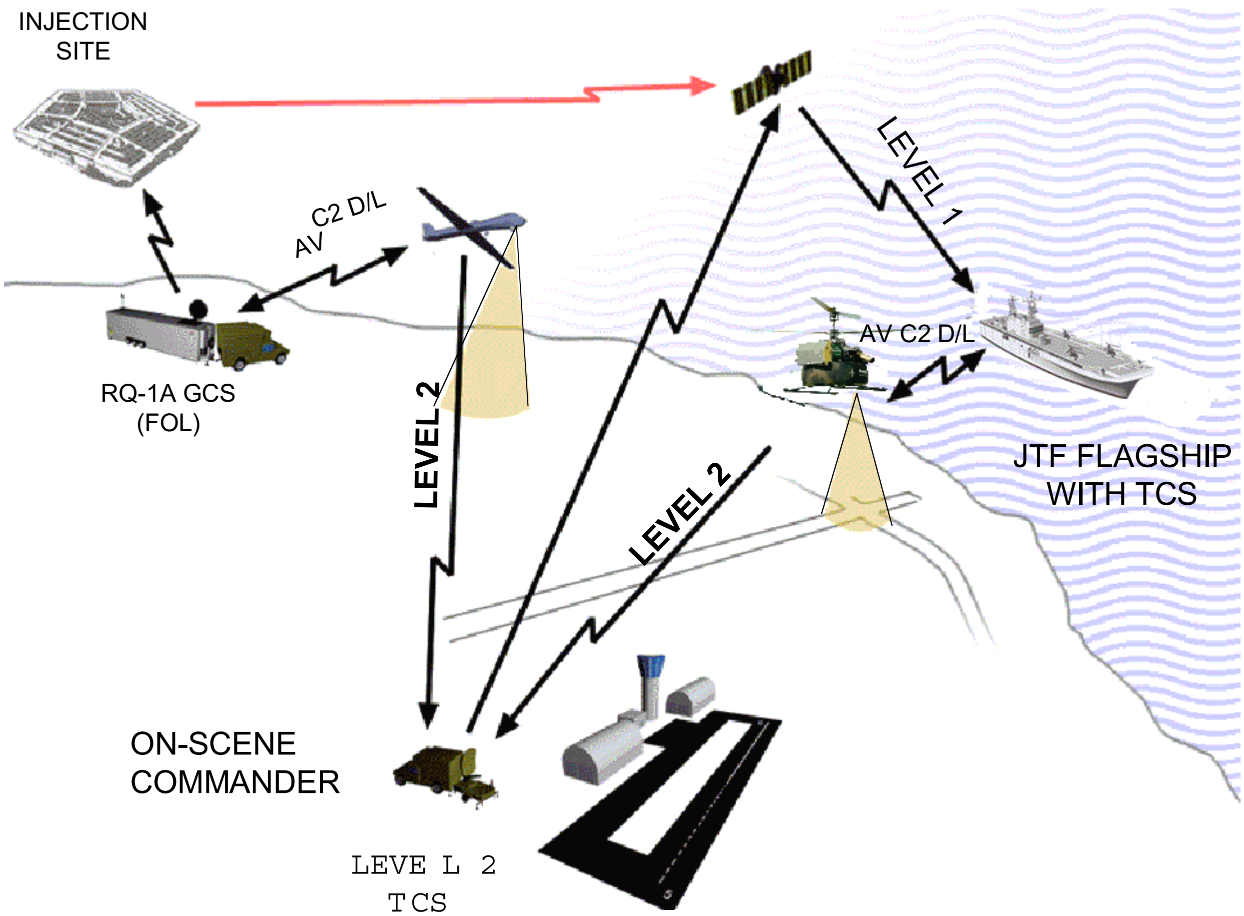

Figure 4-5. Level II TCS Operations

Level II TCS Employment Concept
JFC intent is to support the NEO force with imagery of the immediate and surrounding area to enable early and swift application of force protection assets as required. RQ-1A Predator missions and sea-based VTUAV missions are tasked to provide EO/IR imagery directly to the NEO force. The RQ-1A Predator is operating from an RQ-1A forward operating base several hundred kilometers from the potential evacuation site. The VTUAV is launched from a task force ship stationed close to the coast. The NEO force on-scene commander s tactical operations center TOC (ashore) is TCS capable and is within the LOS downlink footprint of the RQ-1A and is operating at Level II. The imagery and data arrives unfiltered. Analysts on scene are required to interpret critical aspects of the image and provide immediate feedback to decisionmakers. The JFC (embarked) is TCS capable and is conducting Level I operations to receive UAV imagery through SATCOM connectivity.

4.4.3 Level III Operations. Level III TCS operations, which may include Level I or II operations as well, assigns payload control authority and responsibilities directly to the key users of the information during a specific UAV flight or portion of a flight independent of air vehicle control.

Level III TCS operations involve real time control of UAV payloads and both pre-flight and real time payload mission planning. Level III TCS operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

4.4.3.1 Operational Considerations. With appropriate operator training and qualification, and subject to operator currency, TCS-equipped units can conduct Level III operations. TCS Level III operations should be considered when a tactical unit requires the operational responsiveness that direct sensor control offers. Level III operations may also require the interfacing of any UAV-peculiar manual control equipment to control the payload of the UAV(s) being utilized. For operations with UAVs with a single uplink channel, Level III TCS operations require digital communications connectivity between the TCS workstation exercising payload control and the TCS workstation exercising air vehicle control. Real time communications between payload operators and air vehicle operators will improve chances for mission success.

Note: TCS architecture supports remoting payload control to another TCS node through digital connectivity to the AV controlling node. In this case, control latency is inherent due to communications delays and as the payload signal is passed through the AV control node. The Predator UAV has two antenna systems and is not technically limited to a single data link uplink signal for payload and air vehicle control. Therefore, geographically separated Level III operations are theoretically possible with Predator, however, split signal payload and AV control has not been demonstrated.

Note: Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.

4.4.3.1.1 Mission Planning. Level III TCS operations provide preflight payload planning capability and the ability to dynamically retask the payload. Prior coordination and planning between the air vehicle controller and payload controller is absolutely essential for effective Level III operations.

4.4.3.1.2 Handoff Procedures. Handoff procedures, specific to the UAV and associated payload being operated, are required between the air vehicle operator and payload operator(s), including workstation recognition of positive handoff. Pre-mission planning is required to ensure that the air vehicle arrives on-station to facilitate payload handoff. Dynamic payload handoff (an operation where the air vehicle controller can elect to pass payload control to another TCS station) can occur to satisfy emergent ad hoc requirements if proper connectivity is, or can be, established. However, a dynamic payload handoff evolution must be coordinated with the JFC authority to ensure that overall force tasking requirements are not jeopardized. It must also be coordinated with the ACA if airspace adjustment is required.

4.4.3.1.3 Personnel. Additional personnel are not required to support Level III TCS operations, however, temporary assignment of additional personnel may be operationally prudent to conduct operations involving simultaneous or multiple payload control.

4.4.3.1.4 Training/Qualification/Currency Standards. Level III TCS operations require TCS related training. TCS operators require completion of the TCS Core course (see Appendix E) and

Service specific payload operator training and qualification. Payload operator currency standards are as required by individual Services for their UAVs.

4.4.3.2 Service Component Level III Capabilities. The following Service component forces/units will be capable of TCS operations at Level III and below:

Air Force: None

Army:

- Corps
- Military Intelligence Brigade (Echelons above Corps)

Marine Corps:

- Marine Expeditionary Force (MEF) (RQ-1A Predator only*)
- Marine Expeditionary Unit (MEU) (RQ-1A Predator only*)

Navy: None

** Due to current Air Force safety and training policy, Air Force will normally provide RQ-1A trained personnel to operate other Service s TCS for operations requiring RQ-1A Predator support.*

Level III Representative Scenario

JTF ashore is conducting military operations other than war (MOOTW) peacekeeping operations.
Mission: Monitor and report belligerent compliance with United Nations (UN) sanctions. Intervene as necessary, short of armed hostilities, to ensure sanction compliance.

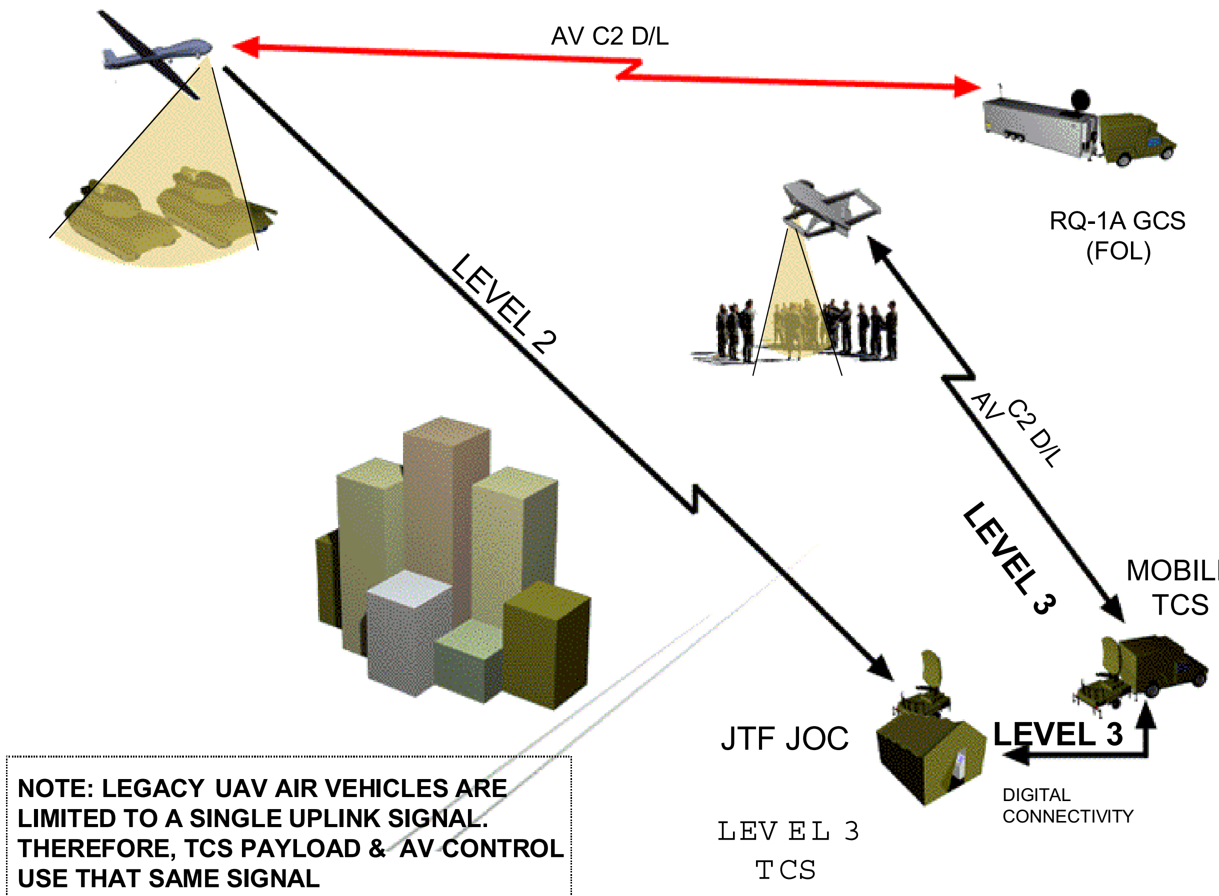

Figure 4-6. Level III TCS Operations

Level III TCS Employment Concept

JFC intent is to optimize the application of limited forces in achieving mission objectives. To improve command and control of this process, the JFC desires to receive real time imagery at Joint Task Force (JTF) headquarters. The preponderance of analytical resources resides at the JFC JOC and payload control from this location will improve situational awareness and quicken sensor retasking. TUAV missions are tasked to provide EO/IR imagery; payload control is assigned to the JTF headquarters. Level III operations are conducted remotely through digital connectivity to the air vehicle control TCS located at the TUAV launch and recovery site near the JTF JOC. RQ-1A Predator missions are also tasked to provide EO/IR imagery to the JOC. RQ-1A Predator air vehicle and payload control is retained at the RQ-1A GCS. The JOC is within the RQ-1A satellite downlink footprint, allowing the JOC to operate Level II with Predator.

4.4.4 Level IV Operations. Level IV operations, which may include Level I, II, or III operations as well, involves a TCS node other than the launching and recovering station(s) controlling the flight of the air vehicle. This enables air vehicle control to be assigned in direct support of a tactical commander closest to the scene of action. This provides that commander with the capability to employ the air vehicle and payload to best meet that force s needs and to speed the delivery of the UAV product to the echelon(s) of the force with the most critical need.

Level IV operations involve real time control of air vehicles and both pre-flight and real-time air vehicle mission planning. Level IV operations may also include dissemination of UAV sensor products to other TCS workstations or C4I systems.

4.4.4.1 Operational Considerations TCS Level IV operations should be considered when a tactical unit requires direct UAV support to accomplish its mission and it is not equipped with organic UAV launch and recovery capability. Level IV operations should also be considered to extend the employment range beyond normal LOS range from the launch site. With proper training or temporary assignment of other Service personnel, cross-component Level IV operations can be conducted by TCS-equipped units. To promote better mission coordination and improve chances for success, Level IV TCS operations should normally have external two-way voice communications between prospective air vehicle control nodes and the launch and recovery node.

Note: Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.

4.4.4.1.1 Mission Planning. Level IV TCS operations provide preflight mission planning capability and the ability to dynamically retask the air vehicle in flight. Both the launch and recovery station and the TCS station desiring inflight control require detailed mission planning capability. Precise route planning is required to ensure the air vehicle arrives in position at the appointed time to facilitate efficient air vehicle handoff. To the extent possible, the launch and recovery station will monitor the flight of the UAV throughout the mission.

4.4.4.1.2 Handoff Procedures. Handoff procedures between air vehicle operators and the launch and recovery operator are required, including workstation recognition of positive handoff. Handoff procedures vary among air vehicles and Services.

4.4.4.1.3 Personnel. Additional personnel are not required to support Level IV TCS operations, however, temporary assignment of additional personnel may be operationally prudent to support high tempo or cross-component operations.

4.4.4.1.4 Training/Qualification/Currency Standards. Level IV TCS operations require TCS related training. TCS operators require completion of the TCS Core course for single UAV operations and completion of the TCS Advanced course for multiple UAV operations (see Appendix E). TCS operators also require Service specific air vehicle operator training and qualification. Service requirements for air vehicle operator currency also applies.

4.4.4.2 Service Component Level IV Capabilities. The following Service component forces/units will be capable of TCS operations at Level IV and below:

Air Force: None

Army:

Reserve Component Separate Brigade

Marine Corps:

MEF/MEU (TUAVs)

Navy:

- Aircraft carrier (CV)/aircraft carrier (nuclear) (CV[N]) - (TUAVs, VTUAVs, and RQ-1A Predator*)
- Amphibious assault ship (LHA)/amphibious assault ship (internal dock) (LHD) - (TUAVs, VTUAVs, and RQ-1A Predator*)
- Cruiser/Destroyer (CruDes) ships - (TUAVs)
- Amphibious command ship (LCC)/ Fleet commander flagship (AGF) - (TUAVs, VTUAVs, and RQ-1A Predator*)
- Attack submarine (nuclear) (SSN) - (TUAVs, VTUAVs, and RQ-1A Predator*)
- MAST/MICFAC - (TUAVs, VTUAVs, and RQ- 1A Predator*)

** Due to current Air Force safety and training policy, Air Force will normally provide RQ-1A trained personnel to operate another Service s TCS for operations requiring RQ-1A Predator support.*

Level IV Representative Scenario

Amphibious task force (ATF) conducting an amphibious operation. Mission: Conduct a joint amphibious landing to seize military objectives ashore. Transfer joint force command ashore once objectives are seized.

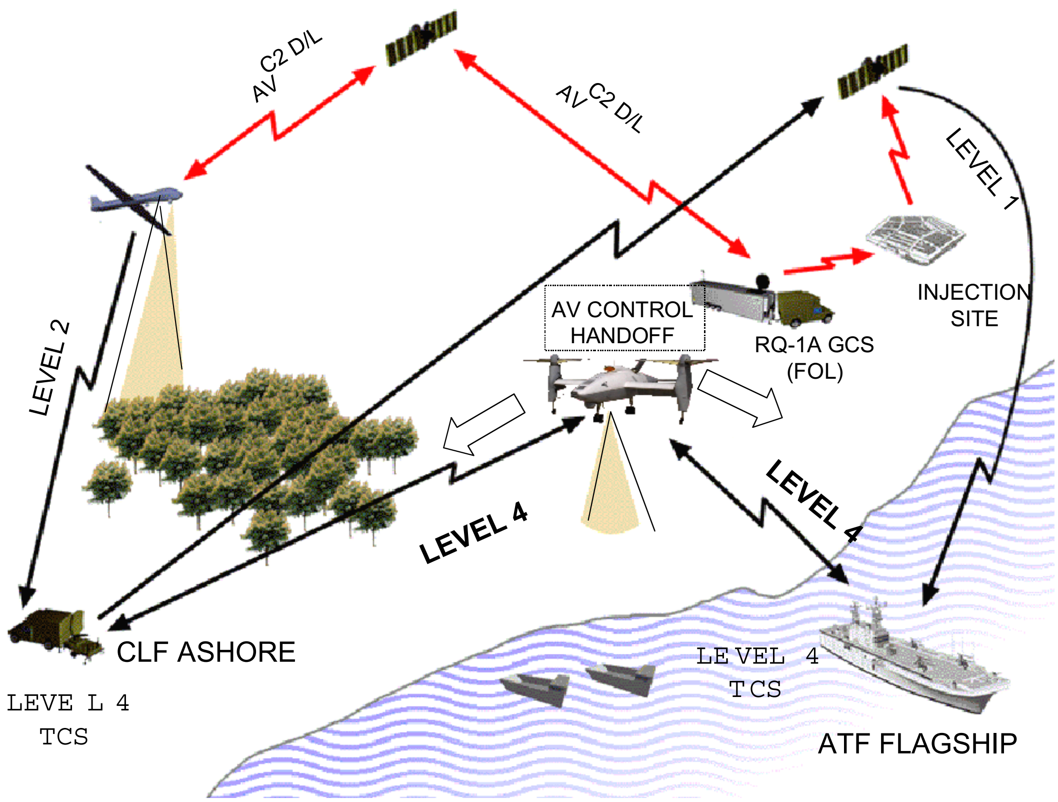

Figure 4-7. Level IV TCS Operations

Level IV TCS Employment Concept
JFC intent is to use real-time imagery prior to the landing operation to assist in IPB. Once the amphibious landing is commenced, real time imagery is required to support targeting of key targets ashore by naval surface fire support. Once forces are ashore, real time imagery will support further maneuver of those forces and establishment of the lodgment. Organic sea-based VTUAV missions are tasked to provide EO/IR imagery; air vehicle control is assigned to the ATF flagship prior to and during the landing. Once landing force TCS capabilities are ashore, air vehicle handoff to the Commander, Landing Force (CLF) TOC will occur until organic VTUAVs can be launched by landing force units. RQ-1A Predator missions are flown from an RQ-1A forward operating location and are tasked to provide SAR imagery prior to commencing the operation. The ATF flagship is receiving RQ-1A Predator SAR video via Level I TCS interaction. Once the CLF has assumed command of the operation, subsequent RQ-1A Predator missions will provide Level II EO/IR mission support to the CLF TOC through Level II operations. Later, as the need arises, the CLF TOC may conduct RQ-1A Predator Level IV operations.*

** Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.*

4.4.5 Level V Operations. Level V operations, which may include all other levels of TCS operations, involve either manual or automatic launch and recovery of the air vehicle. Level V operations also involve responsibility for air vehicle beddown and maintenance support.

4.4.5.1 Operational Considerations. Though TCS will support cross-component Level V operations, current Service reporting custodian policies permit UAV launch and recovery operations by the parent Service only. However, launch of a UAV by one TCS workstation and subsequent recovery by a different TCS workstation within the same Service component provides added operational flexibility, can extend UAV employment range, and may be exercised if the success of the mission requires. In addition, certain airborne emergencies may require UAV recovery by a TCS node other than the UAV launching station.

4.4.5.1.1 Mission Planning. Level V TCS operations provide preflight mission planning capability and the ability to dynamically retask the air vehicle in flight.

4.4.5.1.2 Handoff Procedures. Level V TCS operations incur no additional handoff requirements above those associated with TCS Levels III and IV.

4.4.5.1.3 Personnel. Personnel are required to prepare the air vehicle for launch and to service it upon recovery.

4.4.5.1.4 Training/Qualification/Currency Standards. Level V TCS operations require TCS related training. TCS operators require completion of the TCS Core course and the TCS Advanced course plus Service specific UAV training curricula (see Appendix E). Service requirements for air vehicle operator and payload operator currency also apply.

4.4.5.2 Service Component Level V Capabilities. The following Service component forces/units will be capable of TCS operations up to and including Level V:

- Air Force: None
- Army:
  - Brigade (TUAV)
  - ACR (TUAV)
  - Division (TUAV)
  - Corps (TUAV)
  - Military Intelligence Brigade (Echelons above Corps) (TUAV)
  - Training Base (TUAV)
- Marine Corps:
  - TOC (VTUAV)
- Navy:
  - Amphibious assault ship (LHA)/ amphibious assault ship (internal dock) (LHD) - (VTUAV)
  - Amphibious transport dock (LPD) — (VTUAV)
  - Cruiser/Destroyer (CruDes) ships - (VTUAV)

Level V Representative Scenario

Battlefield maneuver of a joint ground force component. Mission: As part of a joint force campaign, maneuver to engage and defeat enemy ground forces in forward deployed positions.

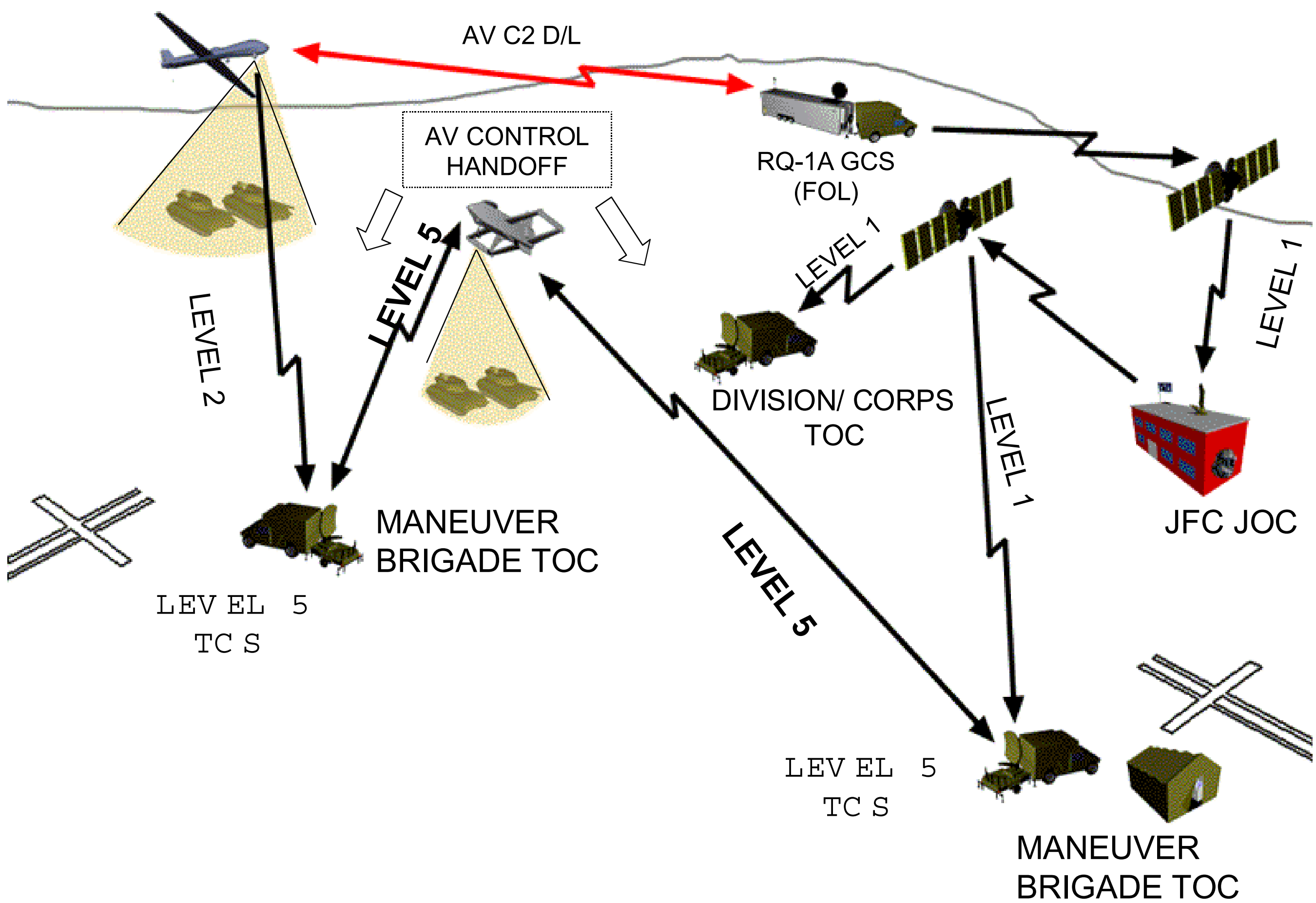

Figure 4-8. Level V TCS Operations

Level V TCS Employment Concept

The JFC has initiated combat operations against the enemy and authorized components to employ organic tactical UAVs for direct mission support. Tactical operations include an air and ground campaign. The ground component commander desires to support the maneuver of tactical ground forces with imagery for RSTA. The ground component commander has assigned Level V direct support control of organic TUAV assets to maneuver brigades for EO/IR targeting of enemy forces. Authorization includes launch of TUAV assets from one location with subsequent handoff and recovery at another location as the tactical situation warrants. RQ-1A Predator missions have also been authorized by the JFC to provide EO/IR imagery directly to ground forces (Level II) when they are within the downlink footprint.

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5.0 OTHER EMPLOYMENT CONCEPTS

5.1 PURPOSE. To summarize additional considerations and factors which influence the operational planning and employment of TCS.

5.2 SAFETY.

5.2.1 Controlled Airspace Operations. Within the US the FAA has classified UAVs as Remotely Operated Aircraft (ROA) and defined procedures for ROA operations in other than special use airspace. FAA Order 7610.4, Special Military Operations, Section 9 of Chapter 12, Change 1 applies. ICAO regulations neither endorse nor provide procedures for the employment of UAVs across national and international divisions of airspace. In some countries and geographic areas, UAV flight is strictly controlled or prohibited. Until a unified set of standards is established, TCS operation of UAVs in controlled airspace will have to be coordinated on a case-by-case basis with the governing airspace organization.

5.2.2 TCS Operator Training and Qualifications. TCS operators require initial training and qualification for the level of operations to be performed. Additionally, TCS operators conducting Level IV and V operations also require currency in the level of operations to be performed and with the specific air vehicle(s) being controlled.

The TCS system is designed to minimize training requirements for TCS operators. Initial training requirements are a function of trainee experience and the TCS operating level being trained to. For Levels III, IV, or V, additional factors impacting single vehicle or multi-vehicle (two or more of the same or different air vehicles) operations will have to be considered. Initial TCS operator training for Levels I and II, and currency maintenance for all levels will be accomplished through computer-based training (CBT) and simulation to the maximum extent possible. Qualification to perform TCS Level III, IV, and V operations requires formalized training. TCS Level IV and V operator training will require training and qualification in appropriate controlled airspace procedures to satisfy FAA/ICAO unmanned air vehicle piloting requirements.

Specific TCS operator training, qualification, and currency standards and maintenance training requirements are detailed in Appendix E. In addition to meeting initial training and qualification requirements for the level of TCS operations that they will perform, TCS operators must also meet Service specific air vehicle or payload control qualification and currency requirements.

5.2.3 Air Vehicle Handoff. Pre-planned or dynamically retasked handoffs of air vehicle control between TCS operators must be properly coordinated. Exact handoff procedures will be specific to the air vehicle involved and must be clearly understood by the TCS operators involved in the AV handoff.

5.2.4 Command Override/Abort. The Service component/UAV unit with reporting custodian responsibility for an air vehicle retains command override/abort capability. When the commander of the UAV unit or that commander s designated representative determines that AV flight safety is jeopardized, a command override or abort may be issued. In such cases, immediate notification of the TCS operator from whom control is being assumed and the TCS tasking authority is required.

5.2.5 UAV Mishaps. UAV mishaps will be handled in accordance with appropriate Service directives and guidance. TCS units involved in either sensor or AV control during a mishap mission will participate in the mishap investigation.

5.3 EMERGENCY PROCEDURES. For improved operating performance and asset conservation, TCS-controlled multiple air vehicle operations should normally integrate more than one TCS controlling authority/station. When multiple TCS controlling authorities are integrated, the JFC/Service component commander will ensure the existence of emergency procedures between those controlling stations to handle contingency situations when control links or C4I connectivity is interrupted. The following general considerations apply:

5.3.1 Lost Link — Air Vehicle. Lost link instructions are the responsibility of the UAV launch and recovery unit and are part of the mission plan. TCS will be capable of adjusting those lost link instructions with the concurrence of the launch and recovery station.

Whenever dynamic retasking modifies an air vehicle programmed flight path, the lost link instructions should be reviewed and updated as required. TCS can perform this update by automatically identifying restricted areas, minimum safe altitude in the current area of operations, fuel required to return to the launch and recovery station, and furnishing other appropriate warnings as they occur so lost link instructions can be updated immediately when required. This precludes the UAV from flying from an ad hoc position back to the first point of the lost link procedure on a route of flight that could endanger the air vehicle. Updating the lost link instructions prevents the air vehicle from crossing a restricted area, encountering a terrain obstacle that was not planned for, or creating a longer than planned return route that may result in the AV running out of fuel.

5.3.2 Lost Link - Payload Control. When the TCS operator exercising control loses payload control, notification will be made to the TCS operator exercising air vehicle control. At that point, the TCS operator that lost the link will provide the controlling TCS operator with an assessment of the reason for loss of control and whether payload control can be regained. The TCS operator with air vehicle control will attempt to reestablish payload control, and if successful, coordinate a payload handoff back to the operator scheduled to have payload control at that point in the mission. If payload control cannot be regained, the mission commander exercising command override/abort authority will provide payload control to continue the mission at the direction of the supported unit or, if this is not possible, abort the mission and inform the appropriate authority.

5.3.3 Lost Authorized Level of Interaction. When conditions preclude a TCS operating station from performing TCS operations at the level assigned, the appropriate authority will be informed with an estimate of the time to reestablish operating capability at the assigned level. Prompt notification will ensure a reassignment of TCS responsibilities can be accomplished as soon as possible, if required.

5.3.4 Lost C4I Connectivity. When a TCS operating station loses its C4I connectivity, the appropriate intelligence, operations, and C4I representatives on the JFC/Service component/other staff will be informed with an estimate of the time to reestablish connectivity. Prompt notification enables the appropriate C4I authority to determine the necessity of establishing alternate C4I paths for TCS products or coordinating the reassignment of TCS responsibilities within the force.

5.4 LOGISTICS/MAINTENANCE CONCEPTS.

5.4.1 General. TCS logistics and maintenance support will be accomplished in accordance with the Joint Integrated Logistics Support Plan (JILSP) and the maintenance concepts and policies of the individual Services exercising OPCON of TCS assets. TCS shall adhere to DoD regulations and policy governing military standards for logistics, tools, and Test, Measurement, and Diagnostic Equipment (TMDE). To the maximum extent possible, general purpose test equipment (GPTE) and common tools resident in each Service will be used to perform all corrective and preventative maintenance at all authorized levels of maintenance. Required tools and test equipment not available within Service inventories will be identified as special tools and special purpose test equipment (SPTE).

5.4.2 Supply Support. Government supply support for the TCS system will be managed by the Naval Inventory Control Point (NAVICP), formerly the Aviation Supply Office (ASO). The NAVICP has been designated program support inventory control point (PSICP) for TCS and related support equipment (SE).

Shipment of TCS and SE spares and repair parts may be commercial on a government bill of lading for continental US (CONUS) destinations and commercial/government transportation for overseas destinations. The most economical mode of transportation consistent with the priority, required delivery date, and transportability constraints will be used. When deemed necessary by the government, automatic test equipment will be shipped commercially in CONUS by air-ride van or equivalent. Shipments will be made in accordance with DoD directives. TCS hardware will be ruggedized to withstand inter and intra theater movement. Shipping containers will be reusable and enable operators to set up equipment within the established timelines for the UAV system being used.

5.4.3 Maintenance Support. TCS maintenance is accomplished at the organizational, intermediate, and depot levels depending upon the nature of repair required. At the organizational and intermediate levels, Services will support TCS as an integral part of their organic UAV system. Maintenance will be in accordance with each Service s UAV maintenance concepts and procedures. Technical manuals will be in a digital format and be suitable for display on joint computer-aided acquisition logistics support (JCALS) compatible equipment or capable of hard copy printout.

- Air Force - Air Force maintenance involves both intermediate and operating level maintenance at Forward Operating Locations (FOL) and will use the maintenance concepts established in Air Combat Command Instruction (ACCI) 21-101, Objective Wing Aircraft Maintenance. 2Exxx Air Force Specialty Code (AFSC) personnel will be responsible for organizational sustainment of TCS equipment.

- Army - Army will use maintenance practices established for Communication, Intelligence and Electronic Warfare (IEW), Aviation, and Ground Systems.

- Marine Corps - TCS will be supported the same way as a Marine Corps squadron with detachments. TCS and equipment specifically related to the flying of UAVs will be handled in accordance with the Naval Aviation Maintenance Program (NAMP).

- Navy - Navy will utilize the NAMP and aviation supply system to support TCS.

5.5 SECURITY

5.5.1 Classification Guidance. Classification guidance for UAVs is provided in the Unmanned Aerial Vehicles Classification Guide (Enclosure 1 to PEO(CU) letter 5513, Ser PEO(CU) /116, dated 11 May 92, Subject: Security Classification Guidance). As part of a UAV system, TCS classification guidance is drawn from this directive. In addition, TCS is considered to be an Information Technology (IT) system in accordance with DoD definitions. Accordingly, TCS software provides computer security mechanisms (i.e., audit, access controls, identification and authentication, etc.)

TCS hardware and software is unclassified unless interconnection or association with other equipment makes it classified. TCS may therefore be operated at the Unclassified level if no classified information is contained within the system, and it is operated in a standalone mode or is connected only to Unclassified networks.

The Block 0 TCS suite of hardware and software will be certified and accredited to operate at the collateral Secret level using the DoD Information Technology Security Certification and Accreditation Process (DITSCAP) as described in DODI 5200.40, dated 30 Dec 97. Accreditation will authorize control of a UAV and its payload; generating, storing, and processing information up to the collateral Secret level; and functioning as a collateral Secret member with C4I systems. Subsequent TCS Blocks may be certified and accredited to operate at higher levels.

When changing from a higher security level to a lower security level, TCS must be sanitized using procedures approved by the TCS Designated Accrediting Authority (DAA).

TCS operators, maintenance technicians, and other personnel with access to TCS displays, hardware, or software shall be properly trained on applicable security procedures and be cleared to the highest classification level of the data that TCS is processing, storing, or transferring.

5.5.2 Physical Security. TCS hardware, software, and documentation shall be physically protected to prevent unauthorized disclosure of information, to prevent unauthorized modification of hardware or software, and to prevent damage to the system.

TCS equipped units are responsible for the preparation of any TCS unique local security procedures which must be approved by the TCS DAA.

5.5.3 Operational Security (OPSEC). TCS OPSEC procedures will be based on those for the UAVs and C4I systems interacting with TCS.

Legacy UAVs interacting with TCS employ unencrypted data links. These links are susceptible to interception and jamming to various degrees. Both active and passive enemy electronic warfare capabilities can be used to provide warning of UAV employment and to target UAVs and TCS control stations. Depending on the operating environment and hostile electronic combat system present, the threat to TCS operations could range from negligible to active jamming and spoofing of the ground station and air vehicle. Because of the operational flexibility TCS provides, particularly for UAV control from mobile locations (HMMWV, shipbased), commanders must assess the threat risk and potential compromise of UAV/TCS control locations against the warfighting value of conducting UAV operations from those nodes.

5.5.4 Communications Security (COMSEC). COMSEC measures will be implemented in accordance with applicable National Security Directives.

5.5.4.1 Data Link Communications. Legacy UAVs interacting with TCS employ unencrypted data links. Future UAVs and upgraded legacy UAV systems may employ encrypted data links using TCDL equipment.

5.5.4.2 Communications with C4I Systems. TCS equipment provides interoperability with various C4I systems. When required by the respective TCS C4I system Interface Design Document (IDD), TCS will incorporate COMSEC devices compatible with that used by the C4I system.

5.5.4.3 TCS Internal Communications. When integrated into the GCS of a UAV system, the organic communications capabilities will provide the necessary voice communications among TCS operators. In this situation, TCS can operate as a member of a local area network (LAN) at the unclassified to collateral secret security level, subject to the conditions in Section 5.5.1.

In the SB configuration, TCS operators are provided access to the ship s communications systems including ship radios, COMSEC equipment, and telephones.

In the LB configuration, TCS provides an intercom system to provide communications among TCS operators. This intercom system is capable of connecting to and interacting with secure and non-secure communications networks.

5.6 NORTH ATLANTIC TREATY ORGANIZATION (NATO)/ALLIED INTER-OPERABILITY. Canada and the United Kingdom have purchased TCS. Other NATO allies are working with the TCS Program Office for the possible procurement of TCS systems.

TCS can support NATO reconnaissance requirements. Early identification of interoperability considerations will assist in developing the interface standards between TCS, NATO UAVs and C4I architectures that will be adopted as NATO Standardization Agreements (STANAGS). Data links are the critical interoperability issue. Three standard data links are being considered. The US common data link (CDL) including tactical interoperable ground data link (TIGDL) is being considered as a line-of-sight, point-to-point data link operating in the I or X Band. No data link has yet been prescribed for the UHF band; however, the Hunter data link is a possible choice. The British have committed to developing a High Integrity Data Link (HIDL) specification that will be available in the summer of 2000 to the U.S. and other NATO partners. Standards for satellite data links must be compliant with commercial standards established by the various international satellite consortiums (international telecommunications satellite (INTELSAT), Pan-American satellite (PANAMSAT). Military SATCOM (MILSAT) can also be used as a possible solution.

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APPENDIX A - TACTICAL CONTROL SYSTEM (TCS) PROGRAM

A.1 PROGRAM MANAGEMENT. The TCS Program Manager (PM), office code: PM-TCS, resides in the Navy PEO-CU. The PM is responsible for the day-to-day direction of the TCS program. Matrix support is provided through the Naval Aviation (NAVAIR) Systems Command Naval Air Warfare Center Aircraft Division (NAWCAD), the Naval Surface Warfare Center Dahlgren Division (NSWCDD), the Systems Integration Laboratory (SIL), Army Aviation and Missile Command (AMCOM) and other field activities and support offices.

A.2 TCS SCHEDULE. TCS is being developed as an ACAT II program under a three-phase development process as shown in Figure A-1.

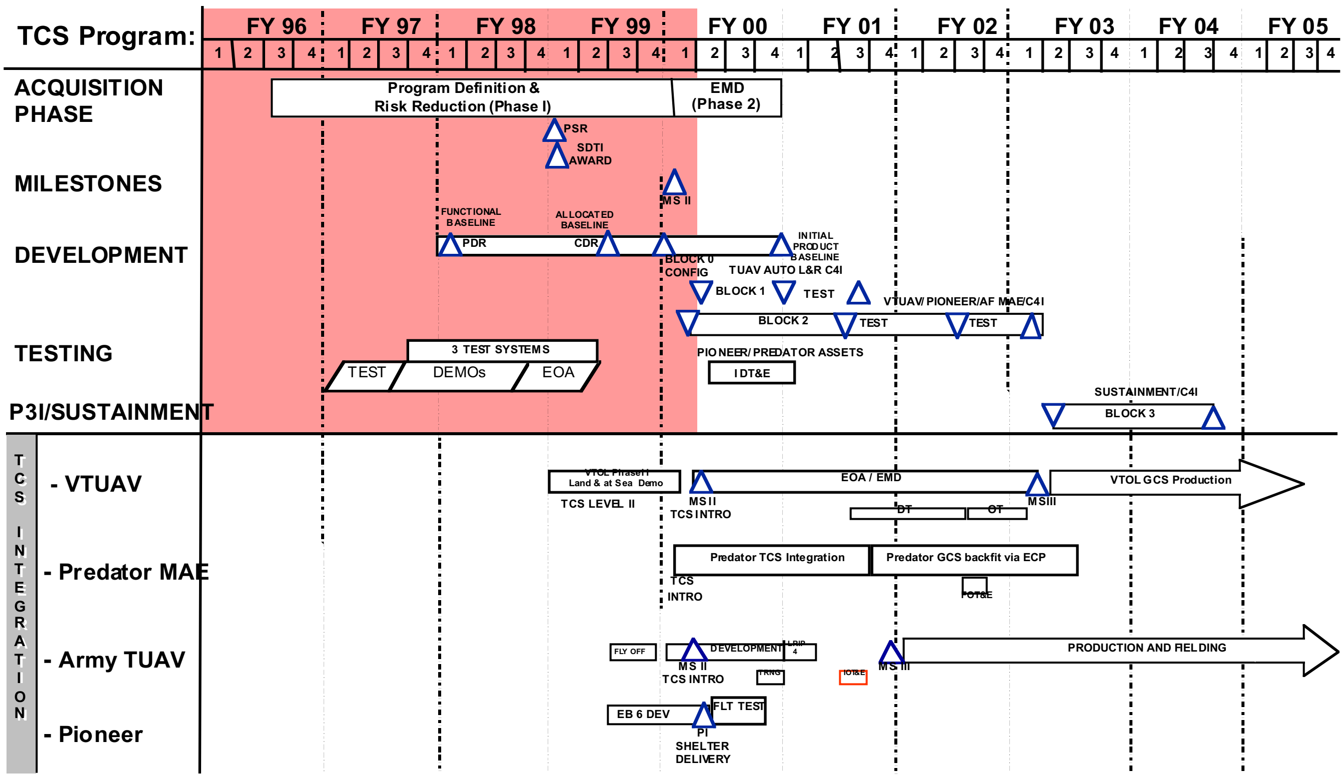

Figure A-1 TCS Schedule (current as of November 1999)

Phase I of the TCS program, began in FY 97 and is scheduled to complete in the second quarter FY 00. During this phase TCS common core functions were interfaced with the Outrider TUAV and RQ-1A Predator air vehicles and payloads. System demonstrations included air vehicle and payload control of the Outrider TUAV and RQ-1A Predator. The TCS prototypes also demonstrated successful interface with eight C4I systems. Lessons learned from TCS demonstrations and employment of TCS in actual joint and Service exercises were incorporated into the TCS development process and acquisition documentation developed during this phase. Phase

I will conclude in February 2000. Phase II will begin with a Milestone II decision in second quarter FY00.

Phase II will focus on engineering and manufacturing development (EMD) and the production of four EDU systems to conduct system DT/OT. System documentation and software developed under Phase I will be provided as government furnished equipment (GFE)/government furnished installation (GFI) to support DT/OT. During this phase fully scalable and modular sea and land-based systems will be integrated with existing platform hardware. Final production system hardware and software configurations will be determined. Phase II will conclude with a Milestone III decision.

Phase III encompasses production, fielding/deployment and operational support of TCS. At this point TCS will have become the command, control, and data dissemination system for the Navy VTUAV, Army TUAV, and all future tactical UAV air vehicles and payloads. For the RQ-1A Predator system, TCS provides additional C4I interfaces for the Predator GCS and provides the technical capability to conduct up to and including Level IV operations from other UAV ground control stations operating with TCS. A contract to construct production systems will be awarded. Additionally, retrofit of RQ-1A Predator systems and validation of remaining C4I interfaces will be accomplished.

A.3 INITIAL OPERATIONAL CAPABILITY (IOC). IOC will be declared by each Service when TCS has completed DT/OT and each Service has fielded one production representative TCS and integrated logistics support (ILS) procurement (training, spares, technical publications, and support equipment) is in place. The level of performance necessary to achieve IOC is defined as one system in the Service specified final configuration with operators and maintenance personnel trained and initial spares with interim repair support in place.

A.4 FULL OPERATIONAL CAPABILITY (FOC). FOC will be declared by each Service when all TCS maintenance and repair support, software support, test equipment and spares are in place and TCS systems are effectively employed.

A.5 SERVICE ACQUISITION. The number of TCS systems to be acquired by the Services and system capabilities are based upon individual Service requirements. Limited Air Force TCS capability will be provided by integrating TCS software into the RQ-1A Predator GCSs by backfitting existing systems. Army TCS capability will support Army requirements at corps, division, brigade, and ACR echelons. Navy TCS capability will support Navy requirements aboard amphibious ships, surface combatants, aircraft carriers, command ships, and submarines. Marine Corps TCS capability will support Marine Corps requirements for expeditionary forces, pre-positioning, and war reserve.

The potential acquisition profile is shown in Figure A-2. Appendix B delineates individual Service requirements for TCS capability for existing UAVs and at various command locations.

SERVICE	FY00	FY01	FY02	FY03	FY04	FY05	FUTURE	TOTALS
Air Force	0	0	3	3	3	3	0	12
Army	10	10	12	13	19	18	28	110
Navy	0	0	3	0	5	5	34	47
Marine Corps	0	1	0	4	2	2	14	23
TOTALS	10	11	18	20	29	28	76	192

Figure A-2 Potential Acquisition Profile (current as of November 1999)

Note: These figures are from the TCS Acquisition Plan and reflect the PEO-CU estimate of life cycle requirements. The numbers do not include standalone systems. The actual acquisition numbers and years are subject to change based on Service priorities and requirements.

A.6 TCS DEMONSTRATION/EXERCISE SCHEDULE. TCS will meet its developmental objectives through a rigorous schedule of system demonstrations and participation in experimentation events and training exercises to validate system functionality and UAV and C4I interfaces. Figure A-3 depicts TCS demonstration milestones.

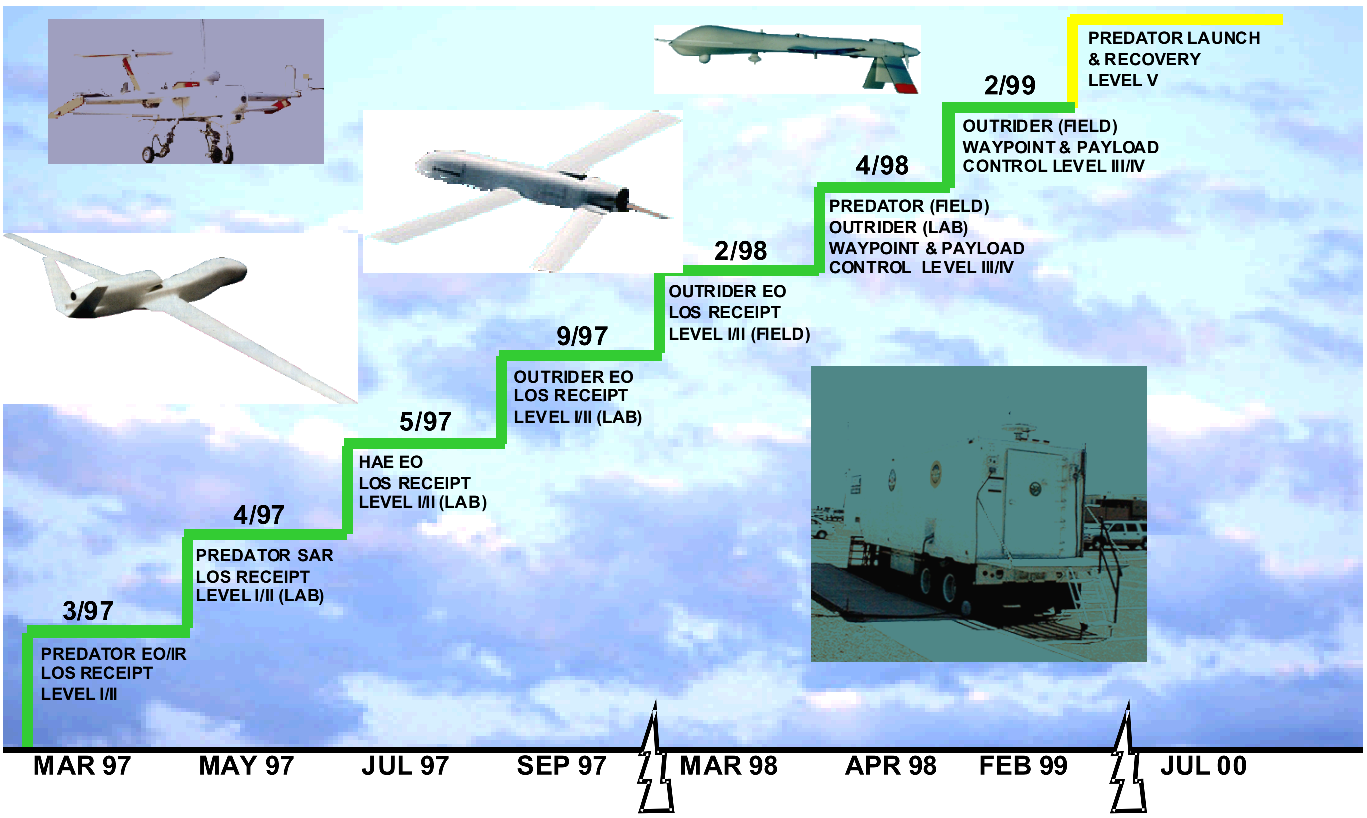

Figure A-3 TCS Demonstration Milestones (current as of November 1999)

APPENDIX B — OPERATIONAL CONFIGURATIONS

Specific capabilities of each TCS will vary according to the hardware configuration based upon the operational requirements of the user. Scalability of hardware allows individual system tailoring to meet the operator s needs for UAV command and control (LOS or BLOS and single UAV or multiple UAV) and type of imagery processing (EO/IR or SAR).

The configurations contained in the following charts represent anticipated capability mixes of Service TCSs by location at which they will be operationally employed:

B.1 AIR FORCE CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
RQ-1A GCS							
RQ-1A Predator	I						
AOC/WOC/IES							
RQ-1A Predator	I						
TUAV/VTUAV	I						

B.2 ARMY CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
TUAV units (Brigade level, Heavy Division)							
TUAV	V	X		X	X	X	X
HAE	I					X	
RQ-1A Predator	IV (1)	X		X	X	X	
VTUAV	IV	X		X		X	
ACR/Division/Corps/ EAC							
TUAV	IV/V (2)	X		X	X	X	X (2)
HAE	IV		X	X	X	X	
RQ-1A Predator	IV (1)	X	X	X	X	X	
VTUAV	IV	X		X		X	
TOC (Army level)							
TUAV	II	X		X	X		
HAE	II		X	X	X		
RQ-1A Predator	II	X	X	X	X		
VTUAV	II	X		X			

Note: (1) Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.
(2) TUAV Level V at ACR and Light Divisions.

B.3 MARINE CORPS CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
VMU/TOC							
HAE	II						
RQ-1A Predator	IV (1)	X		X			
VTUAV	V	X		X		X	X
TUAV	IV	X		X		X	

Note: (1) Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.

B.4 NAVY CAPABILITIES.

UNIT/LOCATION UAV TYPE	TCS LEVEL	LOS	BLOS	EO/IR	SAR	MULTIPLE UAV CONTROL	AUTO LAUNCH & RECOVERY
CV (1)							
HAE	II	X	X	X	X		
RQ-1A Predator	IV (2)	X	X	X	X		
TUAV/VTUAV	IV	X		X		X	
LHA/LHD (1)							
HAE	II	X	X	X	X		
RQ-1A Predator	IV (2)	X	X	X	X		
TUAV/VTUAV	IV	X		X		X	
LPD (1)							
HAE	II	X	X	X	X		
VTUAV	V	X		X		X	X
TUAV	IV	X		X		X	
LCC/AGF (1)							
HAE	II	X	X	X	X		
RQ-1A Predator	IV (2)	X	X	X	X		
TUAV/VTUAV	IV	X		X		X	
CruDes (1)							
HAE	II	X	X	X	X		
VTUAV	V	X		X		X	X
TUAV	IV	X		X		X	
SSN (1)							
HAE	I						
RQ-1A Predator	IV (2)	X		X			
TUAV/VTUAV	IV	X		X			

Note: (1) Not all ships in each ship class will have TCS or if equipped with TCS, the full range of capabilities.
(2) Army, Navy, and Marine Corps are currently prohibited by Air Force safety and training policy from conducting Level III or IV operations with the RQ-1A Predator MAE UAV.

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APPENDIX C — COMMUNICATIONS AND C4I INTERFACES

C.1. COMMUNICATIONS INTERFACES. TCS is interoperable with a wide range of communications media and can interface with existing and future tactical communications networks and systems. TCS can be interfaced to standard DoD deployable (tactical) VHF and UHF line of sight, UHF demand assigned multiple access (DAMA) SATCOM, and HF radios, MSE, and military and commercial satellite communications. TCS is not equipped with its own communications support system and must operate within an existing theater operational architecture.

C.1.1. Communications Media. Figure C-1 contains a partial list of current communications equipment with which TCS can interface. Data rates shown vary depending on the distance and specific application.

COMMUNICATIONS INTERFACE	INTERFACE EQUIPMENT (1)	SENSOR PRODUCT/ INFORMATION TYPE	DATA RATE (2)	ENCRYPTION EQUIPMENT
VHF radio	AN/VRC-89/90/91 SINCGARS	Analog voice, digital voice, tactical message, & image	16 KB/S	KY-57
UHF radio	LST-5, AN/PSC-3, AN/CSZ-4A, ARC-164, AN/WSC-3	Analog voice, digital voice, tactical message, & data	16 KB/S	KY-57/58, KYV-5, KG-84
HF radio	AN/GRC-26D, URT-23/ R-2368, HFRG	Analog voice, digital voice, tactical message, & data	2.4 KB/S	KG-84
UHF SATCOM	LST-5, AN/PSC-3, AN/CSZ-4A, AN/WSC-3	Analog voice, digital voice, tactical message, & data	16 KB/S	KY-57/58, KYV-5, KG-84
LAN	LAN NIC, Routers & Switches	Digital data, imagery, & video clips	10/100 MB/S	KG-194, NES, H.323 & Jvox
RG-59/U	Cameras, monitors, VCR, scan converter, CCTV	Analog video	30 frames/ second	N/A
Serial (RS-232) (3)	DTE, DCE	Digital data & imagery	32 KB/S	KG-84, KY-57, KY-68

COMMUNICATIONS INTERFACE	INTERFACE EQUIPMENT (1)	SENSOR PRODUCT/ INFORMATION TYPE	DATA RATE (2)	ENCRYPTION EQUIPMENT
Serial (RS-422)	DTE, DCE	Digital data, imagery, & slow scan video	100 KB/S	KG-84
2/4 wire (includes MSE)	TA-954, KY-68	Digital voice & tactical message	16 KB/S	KY-68
62.5/125 Multimode Fiber Optic Cable	Cameras, monitors, video switches, LAN	Analog video, E-mail, NITF files	10/100 MB/S	N/A

Figure C-1. Communications Media

Notes: (1) This table is a partial list of currently fielded equipment. Not all models or types are listed.
(2) Data rates vary depending on distance and specific application.
(3) Digital video, serial digital data, and 2 and 4 wire communications media are required to interoperate with designated C4I systems.

C.1.2 TCS Protocols. TCS data communications uses the following protocols -

- Transmission Control Protocol/Internet Protocol (TCP/IP)
- Network File System (NFS)
- Simple Mail Transfer Protocol (SMTP)
- File Transfer Protocol (FTP)
- X.25

to transfer the products described in section C.3.

C.2 C4I INTERFACES. TCS is capable of interfacing with many current joint and Service C4I systems (see Figure C-2 below). In addition, the TCS architecture, hardware, and software are designed such that all future C4I systems will also be interoperable with TCS. Current TCS capabilities to output imagery and data, however, exceed the exploitation capabilities of some C4I systems with which TCS can interface. As an example, TCS can disseminate EO/IR payload video imagery, but not all C4I systems are able to receive and process video imagery.

The TCS-C4I interface involves the exchange of information between the software application running on the TCS core and the software application running on the C4I system. The types of information exchanged include:

- payload information or sensor products such as EO/IR full motion video and freeze frame imagery
- SAR imagery, and metadata such as payload pointing information
- air vehicle state and geoposition data
- mission tasking
- maps

- mission planning information such as waypoints, altitudes, weather, and threat information

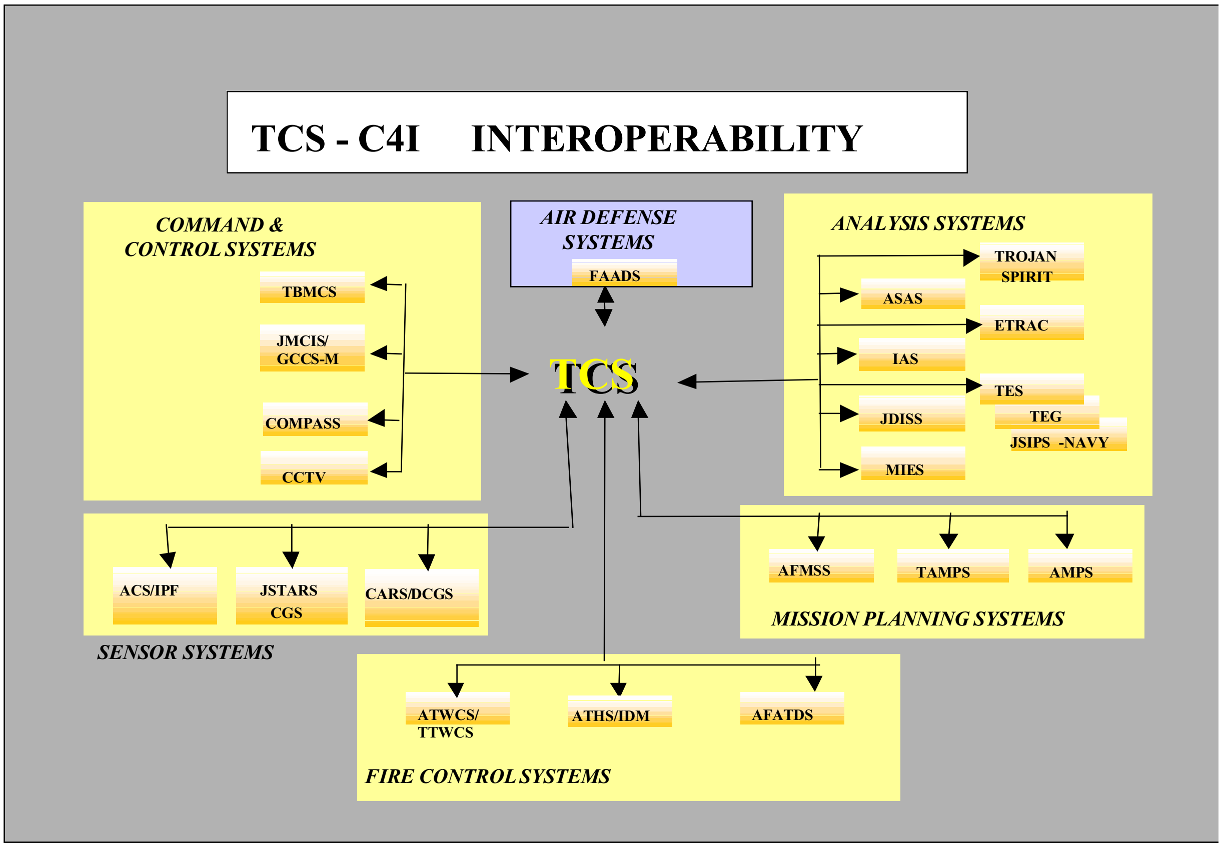

Figure C-2. TCS-C4I Interoperability

The TCS-C4I interface is used to exchange the following products:

- Tactical Messages
- E-mail Messages
- Mission Plans
- Sensor Products
- Voice Communications

C.2.1 Tactical Messages. TCS will use the DII COE Common Message Processor (CMP) to generate tactical messages. The CMP currently supports the following message standards:

- Change 3 to Reissue 2 Package 11 VMF Bit-Oriented Message (BOM) Standardization Document

- VMF Technical Interface Design Plan Test Edition (TIDP TE) Reissue 3

- MIL-STD 6040 US Message Text Format (USMTF). Note: The USMTF 2000 message set that will be implemented on 1 March 2000 includes a subset of the Army Command and Control System (ACCS) Army unique messages and subset of the Intelligence and Electronic Warfare Communications Catalog (IEWCOMCAT) message set.

- Architecture, Design, Analysis and Planning Tool (ADATP-3). ADAPT-3 messages are the NATO equivalent to USMTF.

C.2.2 E-mail. TCS will exchange text messages with C4I systems using the SMTP protocol and using MIME encoding for attachments.

C.2.3 Mission Plans. Mission tasking and planning includes flight route planning, payload/collection planning, communications planning, and dissemination planning. This information is imported and exported through interfaces with Service mission planning systems.

The following typical data elements are representative of acceptable TCS input (for mission planning, status query) or TCS output (mission monitoring, status reporting).

- Common data elements. Mission number, mission date and air vehicle tail numbers are common to all UAV mission related message files transmitted from or to TCS.

- Flight route data elements. These elements describe the mission plan of the UAV, both as input for mission planning and dynamic retasking purposes, and output for monitoring of mission status. Typical information includes the common data elements (defined above), time of update, latitude/longitude, altitude in feet above mean sea level (msl), and true heading in degrees.

- Collection tasking elements. Collection tasking elements are used to create a data collection plan for upload to the air vehicle.

- Communications data elements. These elements describe the communications configuration.

- Threat information data elements. These elements are used to automatically or manually update a threat.

- Weather information data elements. Elements that compose the weather information message.

- Imagery data elements. These elements describe the footprint of an image to be captured.

C.2.4 Sensor Products. The following sensor products can be both received and disseminated by TCS. TCS sensor products may be any of the following:

- **Digital Imagery.** Digital imagery products include National Image Transmission Format (NITF) still imagery frames from both EO/IR and SAR payloads and motion picture experts group (MPEG-2) imagery with metadata encoded in the private data field and metadata overlays via closed caption. NITF is considered to be the suite of standards specified for the exchange, storage, and transmission of digital still frame imagery.

- **Analog Imagery.** Analog imagery is transmitted as National Transmission Standards Committee (NTSC) video in ANSI-SMPTE 170M-1994 format with metadata in either closed caption overlays or encoded via closed caption.

C.2.5 Voice Communications. Analog or digital voice can be used to exchange information via analog voice over VHF, UHF and HF links, SATCOM, and 2 or 4-wire networks. Examples include descriptions of imagery, targets and battle damage assessments. These descriptions may follow the format of a tactical message or be a freeform description.

C.3 C4I Connectivity. Figure C-3 shows the products the TCS provides to various C4I systems and the backbones, intermediate systems, or architectures through which the TCS connects to disseminate those products.

C4I SYSTEM	PRODUCT(S) FROM TCS	BACKBONE, INTERMEDIATE SYSTEM/ARCHITECTURES
AFATDS	Tactical messages	MSE, SINCGARS, wireline
AFMSS	Tactical messages, Mission plans	LAN
AMPS	Mission plans, e-mail, voice, Tactical message	LAN, ACUS MSE, CNR
ASAS	NITF, tactical messages, e-mail, secure voice	Army tactical LAN, MSE, SINCGARS, wireline, CCS LAN
ATHS (IDM)	Tactical messages	SINCGARS
ATWCS (TTWCS)	NITF, tactical messages, e-mail, secure voice	LAN
CARS (DCGS)	NITF, NTCS, MPEG, IPL, e-mail, Voice	IPL, SIPRNET LAN, RG-59/U, 4mm Tape
CCTV	NTSC video, DVS, Voice	RG-59/U cable, 62.5/125 micron fiber
COMPASS	Mission planning data, tactical messages, NITF, e-mail	LAN, MSE
ETRAC	NITF, e-mail, voice	IPL, LAN, STU-III
GUARDRAIL ACS/IPF	SIGINT data	LAN, SIPRNET, HF, VHF, UHF
IAS	NITF, e-mail, voice	LAN, MSE, SINCGARS, Trojan SPIRIT II
JDISS	NITF, NTSC video, e-mail, voice	LAN, RG-59/U, SIPRNET LAN, 62.5/125 micron fiber, Trojan SPIRIT II
JMCIS (GCCS-M)	NITF, NTSC video, tactical messages, voice	IPL, LAN, RG-59/U, 62.5/125 micron fiber, 4mm tape, floppy disk, VHS tape
JSIPS (DCGS)	De-fielded	Replaced by CARS (DCGS)
JSIPS-N	NITF, voice	IPL, LAN, 4mm tape, IVN/IVCS
JSTARS CGS	NTSC video, NITF, e-mail, tactical message, voice, TESAR waterfall	IPL, LAN, RG-59/U, 62.5/125 micron fiber
MIES (TES)	See TES	
TAMPS	Mission plan, tactical messages	SIPRNET, LAN

C4I SYSTEM	PRODUCT(S) FROM TCS	BACKBONE, INTERMEDIATE SYSTEM/ARCHITECTURES
TBMCS	NITF, NTSC video, e-mail, voice	SIPRNET, LAN, RG-59/U, 62.5/125 micron fiber
TEG	NITF, e-mail, video	IPL, SIPRNET, LAN, VHS Tape
TES	NITF	IPL, SIPRNET, LAN, 62.5/125 micron fiber
TROJAN SPIRIT II	NITF, NTSC video, e-mail, voice	LAN, RG-58/U, 62.5/125 micron fiber, RG-59/U

Figure C-3. C4I Connectivity

APPENDIX D — SYSTEM DESIGN, INTERFACES AND FUNCTIONALITY

D.1 SYSTEM DESIGN AND INTERFACES. The scalable and modular capabilities of TCS are inherent design features achieved through interfacing internal TCS hardware and software components with each other and interfacing the entire system externally to supporting equipment and other systems. There are three types of component interfaces: 1) software-to-software, 2) software-to-hardware, and 3) hardware-to-hardware. There are also a number of external system-to-system interfaces.

D.1.1 Software-to-Software Interfaces. TCS has the following software-to-software interfaces:

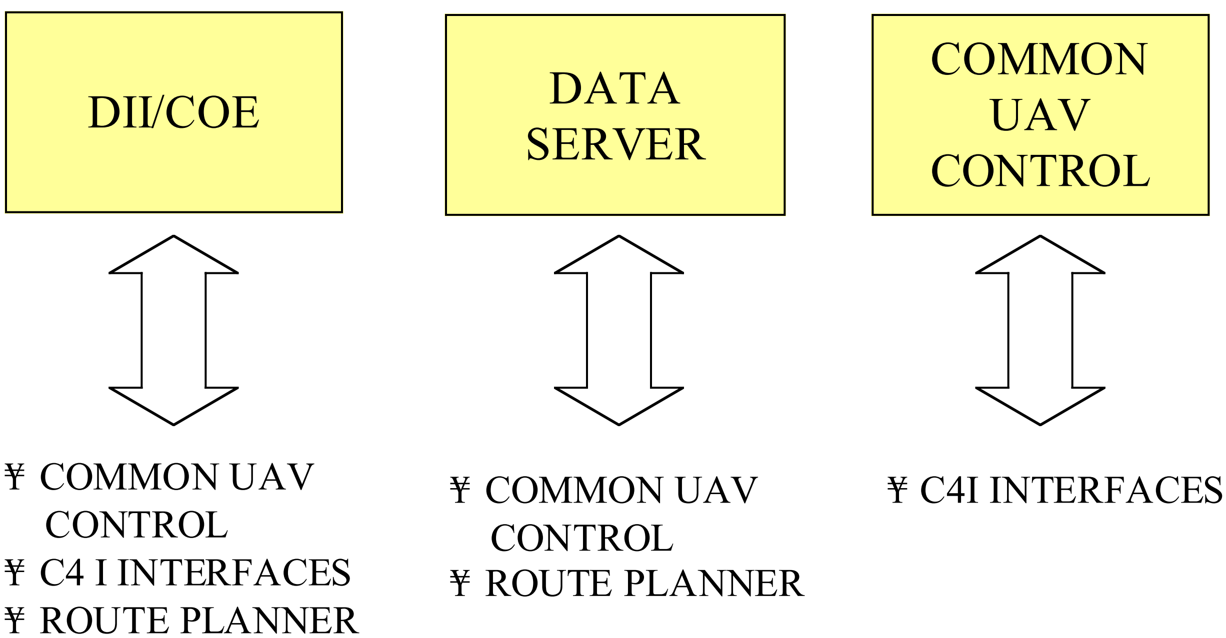

Figure D-1. Software-to-Software Interfaces

D.1.2 Software-to-Hardware Interfaces. TCS has the following software-to-hardware interfaces:

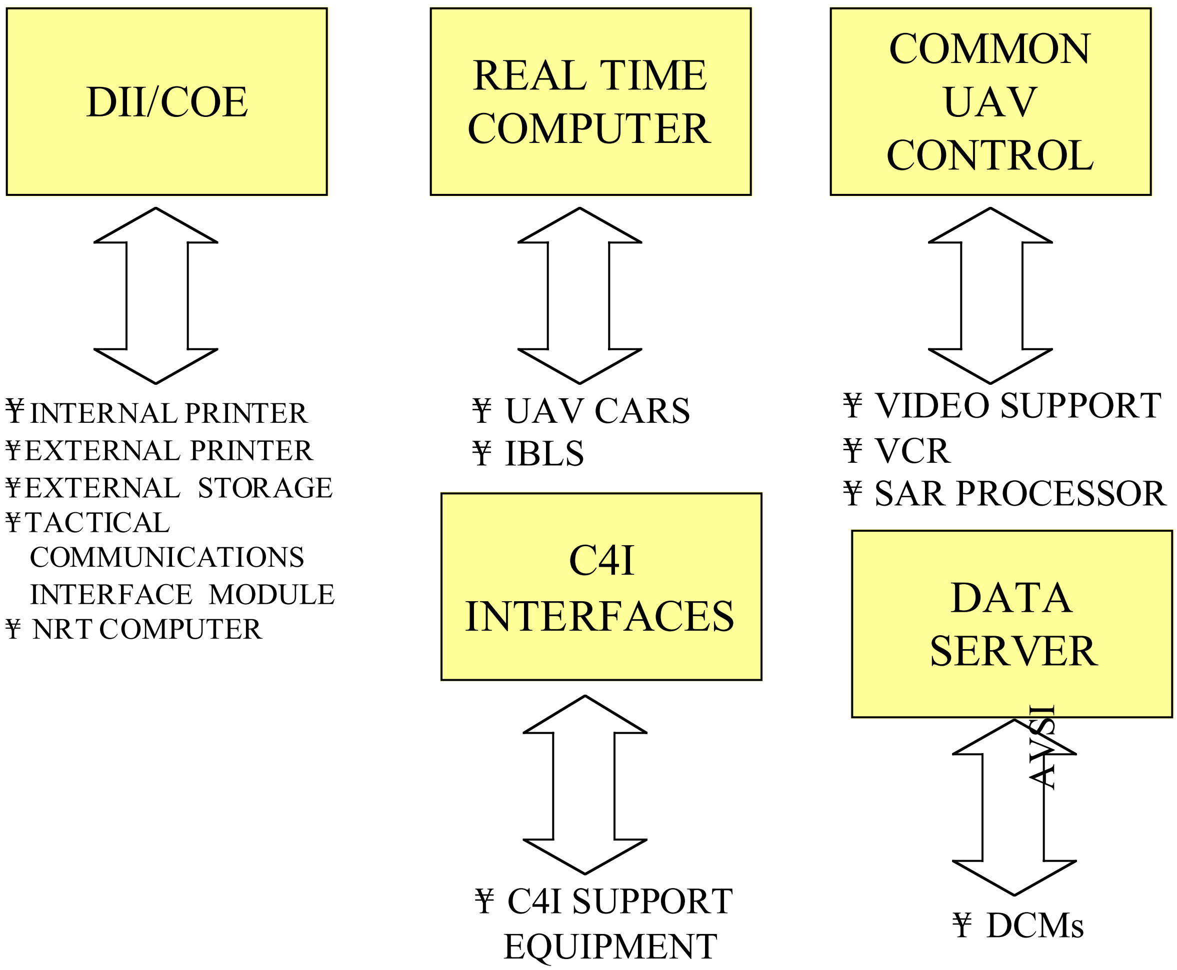

Figure D-2. Software-to-Hardware Interfaces

D.1.3 Hardware-to-Hardware Interfaces. TCS has the following hardware-to-hardware interfaces:

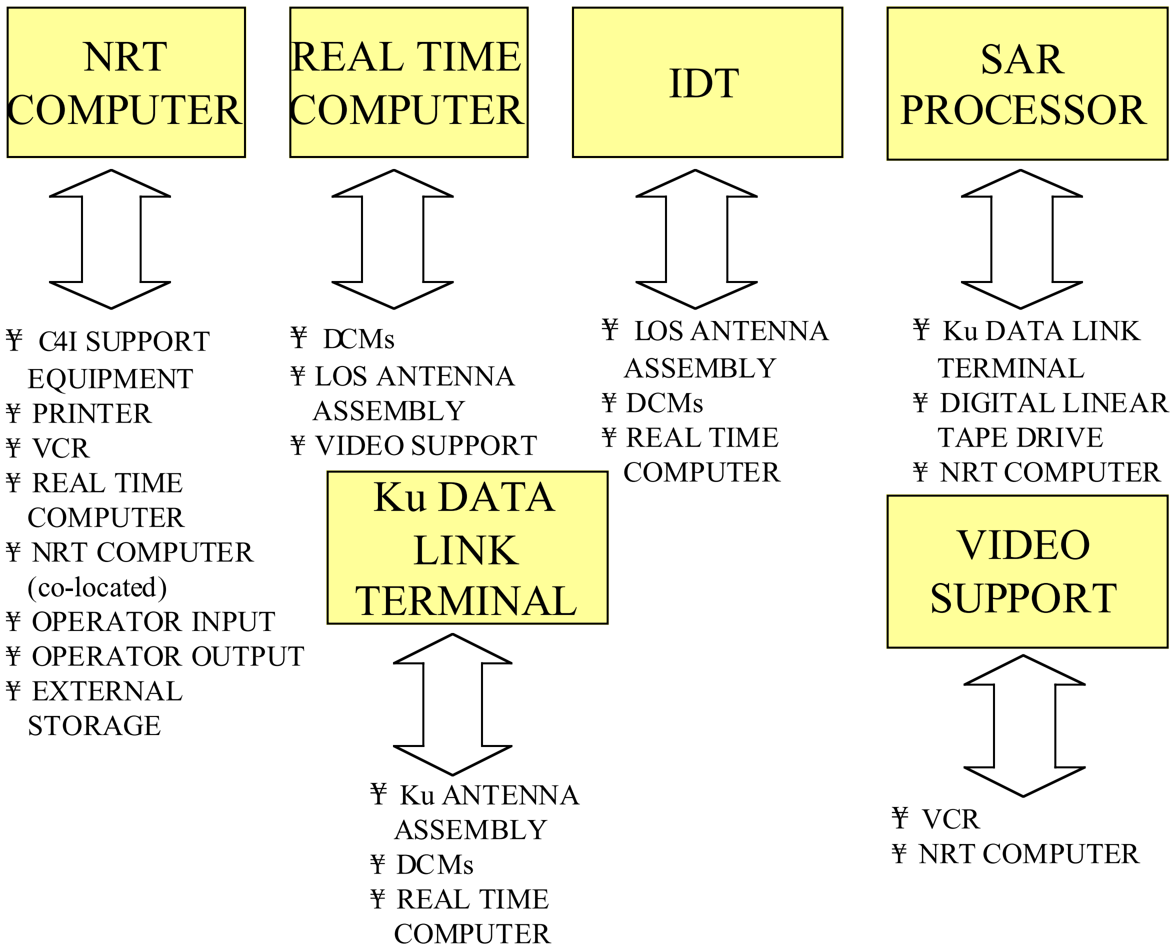

Figure D-3. Hardware-to-Hardware Interfaces

D.1.4 External Interfaces.

D.1.4.1 Power Interfaces. TCS has the following power interfaces: uninterruptable power supply (UPS) to Power Distribution hardware components, UPS to the non-real time (NRT) computer, and UPS to the DCMs.

D.1.4.2 Imagery System Interfaces. TCS will be provided an interface between the NRT computer and the Image Product Library (IPL) as an objective capability. The IPL supports lower level echelon UAV operating sites, imagery exploitation sites, and TOCs. The IPL stores and manages both still and motion imagery in a single unitary domain (both still and motion imagery may be accessed together) primarily in support of near term tactical requirements. A TCS site IPL serves as a short-term imagery buffer for supporting distribution of motion imagery segments to designated users and designated imagery exploitation sites. It also supports preparation of mission archives. The IPL at TCS sites assigned in support of tactical operations will be very localized and address immediate operational imagery needs.

The TCS system is capable of storing a minimum 9.0 gigabytes worth of text and still and motion imagery at each TCS workstation. Organic storage capability enables each TCS site to maintain its own IPL where selected imagery files can be archived, managed, and exploited for certain periods of time. This allows TCS systems to operate independently without C4I connectivity to another IPL or higher echelon image library and to pass high interest archived imagery to that library once connectivity can be established.

D.1.4.3 Launch and Recovery Interfaces. TCS will be provided with interfaces between the real time computer and the UAV CARS and the IBLS as objective capabilities.

D.1.4.4 C4I Interfaces. TCS is capable of interfacing with a wide variety of current joint and Service C4I systems (see Appendix C, figure C-2). In addition, TCS architecture, hardware, and software are designed such that all future C4I systems will also be interoperable with TCS. Current TCS capabilities to output imagery and data, however, exceed the exploitation capabilities of some C4I systems with which TCS can interface.

D.2 SUBSYSTEM FUNCTIONALITY. TCS subsystems are designed with the following functionality. Unless noted otherwise, all functions described are threshold capabilities:

D.2.1 AV Communications Subsystem. The AV Communications Subsystem consists of hardware and software components necessary for communications between TCS and a UAV.

D.2.1.1 Data Link Terminal. Data Link Terminal hardware provides concurrent data uplink and downlink between TCS and an AV.

D.2.1.1.1 Integrated Data Link Terminal (IDT). IDT hardware provides the interface between the DCM hardware and the LOS Antenna Assembly hardware. The IDT performs the same function as the individual GDTs for each specific air vehicle, thereby eliminating the requirement for separate GDTs/antenna assemblies for each air vehicle to be controlled. The IDT is an interim capability supporting TCS development until TCDL is fielded.

D.2.1.1.2 Ku Data Link Terminal. The Ku Data Link Terminal provides the interface between DCM hardware and Ku-equipped AVs.

D.2.1.1.3 Link Manager Assembly (LMA). The function of the Link Manager Assembly (LMA) hardware and software is TBD.

D.2.1.2 DCMs. DCM software provides TCS the capability to receive, transmit, interpret, and record the AV and datalink command and control mission telemetry data in real-time. Data is formatted according to individual AV manufacturer s proprietary requirements. DCM hardware performs real time processing in order to maintain closed-loop communication and control of the AV as well as the required control of the ground-based data link components and communications. DCM hardware also transfers data to the Real Time Processor (RTP) software through the Air Vehicle Standard Interface (AVSI).

D.2.1.3 Antenna Assembly. Antenna Assembly hardware consists of both a C-Band LOS Antenna and a Ku-Band SATCOM Antenna. Both antenna assemblies enable TCS to communicate over the appropriate frequency band with AVs equipped to operate in those bands.

D.2.2 Launch and Recovery Subsystem. The Launch and Recovery Subsystem consists of hardware only and is provided as an objective capability. There are two types of hardware: 1) the IBLS which provides TCS with a differential Global Positioning System (GPS) to launch and recover IBLS capable AVs, and 2) the UAV CARS which provides a microwave based Ka-band system to control and recover UAV CARS-capable AVs.

D.2.3 Real Time Subsystem. The Real Time Subsystem consists of the hardware and software necessary for the real time processing of information.

D.2.3.1 Real Time Computer. Real Time Computer hardware provides the real time processing capability to TCS.

D.2.3.2 Manual Controls. The Manual Controls are TBD.

D.2.3.3 Real Time Processor. Real Time Processor software provides TCS with the capability to receive, transmit, interpret, and record all the AV and datalink command and control mission telemetry data in real-time. Data is formatted according to the AVSI design standards when interfacing to a DCM and in accordance with a specific Interface Design Description (IDD) when interfaced to other components.

D.2.3.4 Data Server. Data Server software to support Levels IV and V resides on the RTP. The data server provides TCS with internal interfaces to other software components to allow telemetry data to be distributed to those components in a distributed processing environment based on a client server relationship.

D.2.4 Payload Subsystem. The Payload Subsystem consists of EO/IR and SAR payloads.

D.2.4.1 EO/IR Payload. The EO/IR Payload has no TCS-specific hardware or software.

D.2.4.2 SAR Payload. The SAR Payload consists of the following hardware and software necessary for SAR payload operations.

D.2.4.2.1 SAR Processor. The SAR Processor hardware provides front end processing of raw SAR imagery and telemetry data for input into the NRT Computer.

D.2.4.2.2 Digital Linear Tape Drive. The Digital Linear Tape Drive hardware records raw SAR data.

D.2.4.2.3 Redundant Array of Inexpensive Disks (RAID). RAID hardware provides buffer storage for approximately 10 minutes of SAR data.

D.2.4.2.4 SAR Payload Computer. The SAR Payload Computer software provides the capability to process SAR imagery into a format viewable by the payload operator or for dissemination to C4I systems.

D.2.4.2.5 Integrated Interface Unit (IIU). The functionality of the IIU is TBD.

D.2.5 Operator Station Subsystem. The Operator Station Subsystem consists of operator output and operator input hardware to display waypoints on a map using a pointing device with keyboard redundancy.

D.2.5.1 NRT Computer. NRT Computer hardware provides the functionality to perform mission planning, mission control and monitoring, payload processing, targeting, and C4I interfacing.

D.2.5.2 Video Support. Video Support hardware provides the capability to receive, amplify, convert, annotate, display, and distribute analog video and the capability to capture still frames of analog video.

D.2.5.3 Operator Output. Operator Output hardware allows TCS operators to receive information from the NRT Computer.

D.2.5.4 Operator Input. Operator Input hardware consists of keyboard, trackball, and joystick (at a minimum) and enables operators to input information into the NRT Computer.

D.2.5.5. Common UAV Control. Common UAV Control software provides the UAV operator with the necessary tools for computer related communications, mission tasking, mission execution, data receipt, data processing, and data dissemination.

D.2.5.6 Mission Planner. Mission Planner software provides TCS operators with the necessary tools for computer related AV and payload mission planning. It consists of the following basic elements: Route Planner, Payload Planner, Data Link Planner, Communications Planner, Plan Monitoring, Training, and Maintenance.

D.2.5.7 DII/COE. DII/COE software provides information management services to include mapping, charting, geodesy, imagery exploitation and IPL services, message processing, and printer control.

D.2.5.8 C4I Interfaces. C4I Interface software provides the capability to:

- Send and receive tactical communications messages.
- Send and receive annotated and unannotated digital imagery.
- Establish and terminate digital communications with C4I systems.
- Establish and terminate digital communications to peripheral devices.
- Send and receive analog imagery in ANSI-SMPTE 170M-1994 format with or without overlay.
- Establish and terminate analog communications to C4I systems.
- Establish and terminate analog communications to peripheral devices.
- Establish a voice interface via intercom systems, headsets, Single Channel Ground and Airborne Radio System (SINCGARS) and other radios, or local area network (LAN)
- Send and receive flight route and mission list data to C4I systems.

D.2.5.9 Fault Detection/Location (FD/L) and Diagnostics. FD/L and Diagnostics software functionality is TBD.

D.2.5.10 Air Vehicle Diagnostics. Air Vehicle Diagnostics software functionality is TBD.

D.2.5.11 Data Server. Data Server software to support Levels 1, 2 and 3 resides on the NRT Computer and supports information flow to and from the AV and provides interfaces to all other internal software.

D.2.6 Communications Subsystem. The Communications Subsystem consists of hardware and software necessary for external voice and data communications.

D.2.6.1 External Storage. External Storage hardware provides additional storage space to the NRT Computer.

D.2.6.2 Printer. TCS Printer hardware provides the capability to print hard copies of digital imagery, mission plans, C4I messages, and FD/L information.

D.2.6.3 Intercom Equipment. Intercom hardware provides verbal communications between multiple collocated TCS operators.

D.2.6.4 C4I Support Equipment. C4I Support Equipment hardware provides the interface with military and commercial satellite communications equipment.

D.2.6.5 Communications Equipment. Communications Equipment hardware provides communications with other military units via MSE or SINCGARS or other radio interfaces.

D.2.7 Power Distribution Subsystem. The Power Distribution Subsystem consists of hardware and software to meet TCS power requirements.

D.2.7.1 UPS. The UPS consists of operator station UPS hardware, which varies dependent upon computer type, and support equipment UPS which provides uninterrupted power for critical phases of mission execution, take-off, and landing to avoid loss of air vehicle control.

D.2.7.2 Power Distribution. Power Distribution hardware provides conditioned and necessary power to the various TCS components.

D.2.8 Configuration Dependent Subsystem. Each TCS configuration contains hardware specific to that configuration s footprint limitations and desired operational capabilities as specified by the user.

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APPENDIX E - TRAINING/QUALIFICATION/CURRENCY

E.1 TRAINING AND QUALIFICATION. Both Service-specific UAV and TCS-specific training and qualification are required for TCS operators and maintenance technicians.

Service specific training and qualification fulfills Service mandated requirements for UAV air vehicle and sensor command and control and maintenance of associated Service unique hardware and software.

TCS specific training and qualification supports TCS interaction with both existing and future UAV systems up to and including the levels of interaction authorized. Training accommodates both single-UAV and multiple-UAV operations and is constructed in modules, scalable to the level of interaction achievable by the supported TCS configuration or operator qualification. Courseware is designed such that it can incorporate new UAVs and capabilities, when available.

E.1.1 Service Training and Qualification. Service UAV operator and maintenance technician training and qualification will be conducted in accordance with formal requirements as prescribed by Service training commands.

E.1.1.1 Air Force. Air Force Instructions 11-2RQ-1, Volume 1, 11-2RQ-1 Volume 2, and 11-2RQ-1, Volume 3 prescribe Air Force UAV training, aircrew evaluation, and operating standards. Air Force requires RQ-1A air vehicle operators to be Rated Officers. Imagery payload operators require an AFSC of 1N1 (Intelligence Imagery Analyst). Communications electronics maintenance technicians require a 2Axxx (Maintenance Career Field) AFSC and system administrators require a 3C0X1 (Communications-Computer Systems Operator) AFSC.

E.1.1.2 Army. Aircrew Training Manual —TC 34-212/UAV Aircrew Training Manual prescribes Army UAV training and qualification standards. Army requires tactical UAV air vehicle operators, including those conducting payload operations and limited data exploitation, to have a Military Occupational Specialty (MOS) code of 96U (UAV Operator). Technicians require a 33R MOS (Airborne EW Systems Repairman). Mechanics currently require a 52D MOS (Small Engine Repairman).

E.1.1.3 Marine Corps. The Joint UAV Training Operating Procedures (JUAVTOPS) Manual prescribes UAV training and qualification standards. Marine Corps requires tactical UAV operators to have a 7314 MOS (UAV internal pilot/payload operator) and a 7316 MOS (UAV external pilot). Technicians and mechanics require 6314 (UAV technician) and 6014 (UAV mechanic) MOSs, respectively.

E.1.1.4 Navy. JUAVTOPS Manual prescribes Navy UAV training and qualification standards. Navy requires qualified personnel as follows: 13XX designator (Mission Commander) and Navy Enlisted Classification (NEC) 8362 (External Pilot, Internal Pilot, and Payload Operator). Mechanics and technicians require an NEC code of 8361 (UAV Maintenance Mechanic/UAV Technician).

E.1.2 TCS Training and Qualification.

E.1.2.1 TCS Training Architecture and Design. Training software leverages the core HCI enabling sensor operators trained and qualified in one UAV system to control different types of payloads with additional TCS training. The software is portable and exportable to the field. The training architecture will use an Interactive Courseware Program (ICW) that is independent but compatible with the TCS core software so that it performs as a stand alone unit or as an embedded non-real time functional element. TCS training software uses internal simulation capabilities and also takes advantage of external simulation sources.

In the Training Operations Mode, TCS provides the capability to train and qualify personnel, and maintain proficiency in the operation of the TCS system, perform simulated TCS UAV control functions, and conduct on-line system troubleshooting. This training capability is alterable without affecting the configuration of the operational software. This capability provides TCS operators and maintenance technicians with embedded or add-on self-paced interactive courseware that duplicates UAV flight performance characteristics, capabilities, and limitations.

The Operations Mode of TCS does not accommodate concurrent training operations with the execution of actual missions, however, in the Operations Mode the processing of training messages, if identified as training messages (i.e., use of the terms DRILL or EXERCISE), can be accomplished concurrently with actual mission communications message processing. TCS operator and maintenance technician training actions and retrievable TCS and UAV parameters are recorded to measure performance and for self-assessment and performance enhancement.

E.1.2.2 TCS Training Implementation. Implementation of TCS training is a Service responsibility. TCS training will be integrated into existing institutional UAV training programs. Training will be balanced between institutional, new equipment, and unit training. Initial training efforts will focus on new equipment training and developing an instructor cadre while maintaining operational capability until institutions and field units can stand-alone. Sustainment training will encompass training at the institutional level and in-service training at the unit level. Training will initially emphasize qualification of individual Service training teams and key personnel who will integrate TCS core training into existing Service/UAV system curricula. Once institutionalized within Service/system curricula, training emphasis will shift to instructors and operators to support the fielded systems and then finally provide advanced training for designated personnel.

E.1.2.3 TCS Training Curriculum. Three training courses will be provided for UAV unit personnel. All courses will be developed in modular format to allow grouping, mixing and matching of functional areas and individual lessons to support differences in existing training syllabi. Training will also be available for non-UAV unit personnel to qualify them to conduct TCS Level I and II operations.

E.1.2.3.1 TCS Operator Core Course: The TCS Operator Core Course will be integrated into existing Initial Qualification Training (IQT)/Replacement Operator training programs. This course trains operators in basic system operation (menus, buttons, windows, etc.) for TCS Levels I - IV for single UAV operations. It consists of training in the following specific areas:

- System Initialization/Shutdown
    - System administrator set-up
        - TCS interactivity level
        - Map display
    - Built in test (BIT)

- Route and Payload Planning
    - Map display
    - Air vehicle route
    - Payload
    - Communications

- Mission Control & Monitor
    - Air vehicle
    - Payload
    - Data link
- Launch & recovery (Level V training)

- Payload Processing
    - Image process
    - Image display
    - Image exploitation

- C4I Interface
    - Communications (text and imagery exchange)
    - Tactical communications (voice and preformatted messages)
    - Data dissemination

- Fault Detection/Isolation
    - BIT
    - Troubleshooting

E.1.2.3.2 TCS Operator Advanced Course. The TCS operator advanced course provides follow-on training and qualification for selected operators in TCS Levels III - V for multi-UAV operations. This training expands the skills and knowledge of TCS operators to enable them to control other UAVs at Levels III - V.

E.1.2.3.3 TCS Maintenance Technician Course. The TCS Maintenance Technician course provides training specific to the different hardware suites of the individual Services and generic training for TCS unique items (DCM, etc.).

E.1.2.3.4 Non-UAV Unit Personnel Training. Personnel not assigned to UAV units or who do not posses the AFSC, MOS, or NEC codes but who require TCS training and qualification will be provided just in time training in the field or use embedded CBT included in the TCS. This training supports the qualification of designated individuals to conduct Level I and II operations. Individuals that may require this training include shipboard Combat Information Center personnel, JFC staff, SOF, etc. Currency/recurrency training is not required.

E.2 CURRENCY. TCS operator currency is required for payload and air vehicle operation. Currency standards are as directed by individual Service directives.

E.2.1 Air Force (RQ-1A Predator UAV). Currency standards are contained in Air Force Instruction 11-2RQ-1, Volume 1. The following table summarizes currency requirements for RQ-1 aircrew. If an aircrew loses a particular currency*, that individual may not perform that sortie or event except for the purpose of regaining currency.

*does not accomplish the event in the past number of days shown

EVENT	TO UPDATE FLY	INEXP	EXP	AFFECTS CMR	TO REGAIN CURRENCY	NOTE
Air Vehicle Operator Sorties						
LPS	LPS	60	90	No	LPS	1
Air Vehicle Operator Events						
Launch Procedures	Event	30	45	No	Event	1 & 5
Engine-out Pattern	Event	30	45	No	Event	1
Precision Approach	Event	30	45	No	Event	1
Non-precision App	Event	30	45	No	Event	1
Nose Camera Ldg	Event	30	45	No	Event	1 & 4
Infrared (IR) Landing	Event	30	45	No	Event	1 & 4
Instructor	Event	N/A	60	No	Event	2
Sensor Operator Sorties						
RAP Sortie	Sortie	30	45	No	Sortie	1
Sensor Operator Events						
Operational Msn Plan	Event	30	45	No	Event	1 & 5
Emergency Msn Plan	Event	30	45	No	Event	1 & 5
Mission Monitoring	Event	30	45	No	Event	1 & 5
Ku Target Acquire	Event	30	45	No	Event	1
Line of Sight (LOS) Target Acquisition	Event	30	45	No	Event	1
Mode 1 SAR Target Acquisition	Event	30	45	No	Event	1 & 5
Mode 2 SAR Target Acquisition	Event	30	45	No	Event	1 & 5
Right Seat TO Pro	Event	45	60	No	Event	1* & 5
Right Seat Ldg Pro	Event	30	45	No	Event	1* & 5
Menu Drills	Event	15	30	No	Event	3 & 5
Instructor	Event	N/A	60	No	Event	2

NOTES:

1. Supervision level for recurrency is an instructor qualified and current in sortie/event. *Either an instructor AVO or instructor SO can supervise recurrency for this event.
2. Instructor currency is 60 days. Non-currency for 61-180 days requires a recurrency flight with an instructor. Non-currency for 181 days & more requires a flight evaluation.
3. The supervision level for recurrency is an SO, current and qualified in the event. Non-currency for over 90 days requires instructor supervision for recurrency.
4. AVOs may accomplish a total of three touch-and-go landings per sortie. A full-stop taxi-back landing is counted and limited the same as a touch-and-go landing. IQT, LPS, and SQ supervisor directed

training sorties are not number limited for touch-and-go landings. Refer to AFI 11-2RQ-1V3, *RQ-1 Operations Procedures*, Chapter 3, for guidance on AVO authorization to perform touch-and-go landings.

5. Instructors may log this event for currency when they instruct it.

Aircrew members require recurrency whenever they exceed a currency requirement in this instruction. Aircrew members must satisfy overdue training requirements before performing tasks applicable to the type of training in which delinquent.

Loss of landing/sortie recurrency requires the following action (timing starts from last landing/sortie):

- 31-90 days (46-90 days for experienced aircrew) — regain landing/sortie currency. Supervision level is an instructor qualified and current in the sortie/event.
- 91-135 days —same as above plus instructor supervised OFT.
- 136-210 days (136-245 days for experienced aircrew) —same as above plus qualification and tactical written examinations and emergency procedures examination
- 211 or more days (246 or more days for experienced aircrew) —sorties/events/OFTs as determined by the unit commander plus qualification and tactical written examinations, emergency procedures examination, and qualification/mission flight evaluation.

E.2.2 Army. Currency standards, which are summarized below, are contained in TC 34-212/UAV Aircrew Training Manual.

- Payload control:
  - Less than 90 days —one local flight of 30 minutes duration.
  - More than 90 days — satisfactory completion of a hands-on performance test conducted by an Instructor Pilot, Standardization Instructor Pilot, or Maintenance Test Flight Evaluator.
- Air vehicle control:
  - Less than 90 days —one local flight of 30 minutes duration to include preflight, launch, traffic pattern, emergencies and landing.
  - More than 90 days — satisfactory completion of a hands-on performance test conducted by an Instructor Pilot, Standardization Instructor Pilot, or Maintenance Test Flight Evaluator.
- Air vehicle launch and recovery (EP):
  - Day
    - Less than 45 days —one rolling takeoff, one full stop landing, 30 minutes of local flight time including touch and go landings and simulated emergencies, and passing of bold face action emergency procedures written exam.
  - Night
    - Less than 90 days —one rolling takeoff, one full stop landing, 30 minutes of local flight time including touch and go landings and simulated emergencies, and runway set-up for night operations. Day currency requirements must be met within 5 days prior to night flight operations to include one daytime takeoff and landing.

When currency has lapsed over 90 days, the operator must undergo simulator training to the satisfaction of an instructor pilot (IP) and then meet the less than 90 day currency requirement.

Note: Tasks that can be accomplished in the simulator may be utilized to meet currency requirements with the exception that the simulator may not be utilized for two consecutive currency flights.

Semi-annual hour requirements:

- EP — 12 hours
- VO — 10 hours
- Payload operator (PO) — 10 hours

Note: Operators qualified as both VO and PO require 5 hours of VO time and 5 hours of PO time.

E.2.3 Marine Corps. Currency standards, which are summarized below, are contained in the JUAVTOPS Manual.

- Internal pilots, mission commanders, and payload operators that have not operated a tactical UAV in their respective positions within the last 90 days require a refresher flight under the supervision of a certified instructor.
- External pilot currency is based on requirements contained in the following chart. These requirements must be met every 60-day period. If currency lapses, a recurrency flight with an EP instructor is required consisting of one takeoff, five touch and go landings or low approaches, and one landing. Before the recurrency flight, one hour of training device time with an EP instructor is required.

EP Currency	Takeoff/Launch	Touch & go (T&G) or low approach (LA)	Landings	Training Device
Shore day	2	10	2	6 hours
Shore night	1	5	1	2 hours
Sea day	2	15	2	6 hours
Sea night	1	5	1	2 hours

- External pilots that have not flown in one week require a 1 hour training device flight prior to an actual tactical UAV flight (note: a day flight must be flown within 5 days prior to a night flight).
- Each crew position is required to complete a written examination and flight evaluation annually.
- Unit commanders are authorized to waive, in writing, minimum flight and training requirements where recent experience and knowledge of UAV operations warrant.

E.2.4 Navy. Currency standards, which are summarized below, are contained in the JUAVTOPS Manual.

- Payload control:
  - Less than 90 days — one flight
  - Greater than 90 days —one refresher flight under the supervision of an instructor pilot
- Air vehicle control:
  - Less than 90 days — one flight
  - Greater than 90 days —one refresher flight under the supervision of an instructor pilot
- Air vehicle launch and recovery:
  - Shorebased operations —
    - Less than 45 days —one flight with one takeoff, five touch and go landings, and one recovery
    - Greater than 45 days —one training device flight under the supervision of a qualified external pilot
  - Shipboard operations —
    - Less than 45 days —one flight with one takeoff, five approaches, and one recovery

  - Greater than 45 days —one training device flight under the supervision of a qualified external pilot
- Night currency —one night flight within 5 days of a day flight

APPENDIX F — REFERENCES

The documents and publications listed below were used in the preparation of this Concept of Operations or provide amplifying or more detailed information regarding TCS.

F.1 DoD DOCUMENTS.

ASN (RDA) Memorandum dated 12 Sep 1997, Tactical Control System, Acquisition Category II Designation

Defense Airborne Reconnaissance Office (DARO) UAV Annual Report, 6 Nov 97

DoD Directive 5200.28(D), Security Requirements for Automated Information Systems, 21 Mar 88

DUSD (A & T) Memorandum dated 21 Dec 95, Initiating the TUAV ACTD

DoD Instruction 5200.40, DoD Information Technology Security Certification and Accreditation Process (DITSCAP), 30 Dec 97

F.2 JCS DOCUMENTS.

CJCSI 3250.1, Sensitive Reconnaissance Operations, Apr 96

CJCSM 3500.4A, Universal Joint Task List, 13 Sep 96

Joint Pub 2-0, Doctrine for Intelligence Support to Joint Operations, 5 May 95

Joint Pub 2-01, Joint Intelligence Support to Military Operations, 20 Nov 96

Joint Pub 3-01.4, JTTP for Suppression of Enemy Air Defenses, 25 Jul 95

Joint Pub 3-01.5, Joint Doctrine for Theater Missile Defense, 22 Feb 96

Joint Pub 3-02, Joint Doctrine for Amphibious Operations, 8 Oct 92

Joint Pub 3-07.4, Joint Counterdrug Operations, 17 Feb 98

Joint Pub 3-50.2, Doctrine for Joint Combat Search and Rescue, 26 Jan 96

Joint Pub 3-52, Doctrine for Joint Airspace Control in a Combat Zone, 22 Jul 95

Joint Pub 3-55, Doctrine for Reconnaissance, Surveillance, and Target Acquisition Support for Joint Operations, 14 Apr 93
Joint Pub 3-55.1, JTTP for Unmanned Aerial Vehicles, 27 Aug 93

Joint Pub 3-56.1, Command and Control for Joint Air Operations, 14 Nov 94

JROCM 011-97 dated 3 Feb 97, Unmanned Aerial Vehicle (UAV) Tactical Control System (TCS) Operational Requirements Document (ORD)

JROCM 010-96 dated 12 Feb 96, Predator Unmanned Aerial Vehicle

JROCM 135-95 dated 31 Oct 95, Tactical Unmanned Aerial Vehicle

JROCM 003-90 dated 5 Jan 90, Mission Needs Statements for Close Range Reconnaissance, Surveillance, and Target Acquisition (RSTA) Capability and Long Endurance Reconnaissance, Surveillance, and Target Acquisition (RSTA) Capability

JROCM 034-99 dated 22 Mar 99, Unmanned Aerial Vehicle (UAV) Tactical Control System (TCS) Interoperability

JROCM 010-00 dated 3 February 00, Tactical Control System (TCS) Operational Requirements Document (ORD)

F.3 PEO-CU DOCUMENTS.

Configuration Management (CM) Plan for the UAV Tactical Control System (TCS) Version 1.0, April 98

Tactical Unmanned Aerial Vehicles Overview, 1997

TCS Block 0 Software Requirements Specification (SRS), Version 1.4, 11 Mar 99

TCS Joint Interoperability Interface 2, TCS to Service Command, Control, Communications, and Intelligence (C4I) Systems, Version 1.1, 8 May 98

TCS System/Subsystem Design Description (SSDD), Version 2.0, 26 Feb 99

TCS System/Subsystem Specification (SSS), Version 2.0, 12 Feb 99

UAV TCS Program Management Plan (PMP), Version 4.1, 6 Aug 1997

Unmanned Aerial Vehicles Classification Guide, Enclosure (1) to PEO(CU) ltr 5513, Ser PEO(CU)/116, 11 May 92

F.4 SERVICE DOCUMENTS.

Air Force

Air Combat Command (ACC) Concept of Operations for Endurance Unmanned Aerial Vehicles, Version 3, 1 Apr 98

Air Force Instruction (AFI) 11-2RQ-1 Volume 1, RQ-1 Aircrew Training

Air Force Instruction (AFI) 11-2RQ-1 Volume 2, RQ-1 Aircrew Evaluation Criteria

Air Force Instruction (AFI) 11-2RQ-1 Volume 3, RQ-1 Operations Procedures

Army

Army TC 34-212, UAV Aircrew Training Manual, 27 Aug 97

Marine Corps

JUAVTOPS Flight Manual, Pioneer Unmanned Aerial Vehicle, 5 Mar 97

Navy

JUAVTOPS Flight Manual, Pioneer Unmanned Aerial Vehicle, 5 Mar 97

F.5 MISCELLANEOUS DOCUMENTS.

USACOM HAE UAV Joint Employment CONOPS, 15 Jul 98

Variable Message Format Technical Interface Design Plan (VMF TIDP)

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APPENDIX G — GLOSSARY

PART I - ABBREVIATIONS and ACRONYMS

ACA	Airspace Control Authority
ACAT	acquisition category
ACC	Air Combat Command
ACCI	ACC Instruction
ACCS	Army Command and Control System
ACE	Aviation Combat Element (MAGTF)
ACOM	United States Atlantic Command
ACR	Armored Cavalry Regiment
ACS	Aerial Common Sensor
ACTD	Advanced Concept Technology Demonstration
ADATP	Architecture, Design, Analysis, and Planning
ADCON	administrative control
ADT	air vehicle data terminal
AFATDS	Advanced Field Artillery Tactical Data System
AFI	Air Force Instruction
AFMSS	Air Force Mission Support System
AFSC	Air Force Specialty Code
AGF	amphibious flagship
AIS	automated information system
AMCOM	Army Aviation and Missile Command
AMPS	Aviation Mission Planning System
AOC	Air Operations Center
AOR	area of responsibility
ASAS	All Source Analysis System
ASO	Aviation Supply Office
ATF	amphibious task force
ATHS	Automated Target Handoff System
ATM	Army Training Manual, Asynchronous Transfer Mode
ATO	Air Tasking Order
ATWCS	Advanced Tomahawk Weapons Control System
AV	air vehicle
AVO	air vehicle operator
AVSI	air vehicle standard interface
BDA	battle damage assessment
BIT	built in test
BLOS	beyond line-of-sight

C2	command and control
C4I	command, control, communications, computers and intelligence
CARS	Contingency Airborne Reconnaissance System, Common Automated Recovery System
CAS	close air support
CBT	computer-based training
CCD	camouflage, concealment, and deception
CCTV	closed circuit TV
CDL	common data link
CIGSS	Common Imagery Ground/Surface Station
CINC	Commander in Chief
CGS	common ground segment, common ground station
CJCS	Chairman of the Joint Chiefs of Staff
CLF	Commander, Landing Force
CM	collection manager/collection management
CMA	collection management authority
CMP	Common Message Processor
COCOM	combatant command
COE	Common Operating Environment
COMPASS	Common Operational Modeling, Planning, and Simulation System
COMSEC	communications security
CONOPS	concept of operations
CONUS	Continental United States
CV/CV(N)	aircraft carrier/aircraft carrier (nuclear)
DAA	designated accreditation authority
DAMA	demand assigned multiple access
DARO	Defense Airborne Reconnaissance Office
DARS	Daily Airborne Reconnaissance Surveillance/Syndicate
DCM	data link control module
DII	Defense Information Infrastructure
DITSCAP	DoD Information Technology Security Certification and Accreditation Process
DoD	Department of Defense
DT	developmental testing
DUSD (A & T)	Deputy Under Secretary of Defense (Acquisition and Technology)
EDU	engineering development unit
EMD	engineering, manufacturing, development
EO	electro-optical
EP	external pilot

ETRAC	Enhanced Tactical Radar Correlator
EUAV	endurance UAV
EW	electronic warfare
FAA	Federal Aviation Administration
FATDS	Field Artillery Tactical Data System
FOC	full operational capability
FOL	forward operating location
FTP	file transfer protocol
Gb	gigabyte
GBS	Global Broadcast Service
GCCS	Global Command and Control System
GCE	Ground Combat Element
GCS	Guardrail Common Sensor/ground control station
GDT	ground data terminal
GFE	government furnished equipment
GFI	government furnished installation
GPS	Global Positioning System
GPTE	general purpose test equipment
HAE	high altitude endurance
HCI	human computer interface
HF	high frequency
HMMWV	high mobility multi-purpose wheeled vehicle
IAS	Imagery Analysis System
IBLS	Integrity Beacon Landing System
ICAO	International Civil Aviation Organization
IDD	Interface Design Document
IDT	integrated data terminal
IES	Imagery Exploitation System
IEW	intelligence and electronic warfare
IEWCOMCAT	Intelligence and Electronic Warfare Communications Catalog
IIU	integrated interface unit
ILS	integrated logistics support
ILSP	Integrated Logistics Support Plan
IMINT	imagery intelligence
INTELSAT	international telecommunications satellite
IOC	initial operational capability
IP	internal pilot, Internet protocol, instructor pilot
IPA	imagery product archive

IPB	intelligence preparation of the battlefield
IPF	Integrated Processing Facility
IPL	imagery product library
IQT	initial qualification training
IR	infrared
ISR	intelligence, surveillance, reconnaissance
J2	Intelligence Officer
J3	Operations Officer
JAOC	Joint Air Operations Center
JCALS	joint computer-aided acquisition logistics support
JDISS	Joint Deployable Intelligence Support System
JFACC	Joint Force Air Component Commander
JFC	Joint Force Commander
JIC	Joint Intelligence Center
JII	joint integration interface
JMCIS	Joint Maritime Command Information System
JPEG	joint photographic experts group
JOC	Joint Operations Center
JROC	Joint Requirements Oversight Council
JROCM	JROC Memorandum
JSIPS	Joint Service Imagery Processing System
JSIPS-N	Joint Service Imagery Processing System-Navy
JSTARS	Joint Surveillance, Target Attack Radar System
JTA	Joint Technical Architecture
JTF	Joint Task Force
JUAVTOPS	Joint UAV Training Operating Procedures
JWICS	Joint Worldwide Intelligence Communications System
JWPG	Joint Warfighter Planning Group
Kbs	kilobytes per second
LA	low approach
LAN	local area network
LB	land-based
LCC	amphibious command ship
LHA	amphibious assault ship
LHD	amphibious assault ship (internal dock)
LMA	Link Manager Assembly
LNO	liaison officer
LO	low observable

LOS	line-of-sight
LPD	amphibious transport dock ship
MAE	medium altitude endurance
MAGTF	Marine Air-Ground Task Force
MAST	Mobile Ashore Support Terminal
Mb	megabyte
Mbs	megabytes per second
MEF	Marine Expeditionary Force
MEU	Marine Expeditionary Unit
MICFAC	Mobile Integrated Command Facility
MIES	Modernized Imagery Exploitation System
MNS	mission need statement
MOOTW	military operations other than war
MOS	military occupational specialty
MPEG	motion pictures experts group
MPO	mission payload operator
MSE	Mobile Subscriber Equipment
MSL	mean sea level
MTBF	mean team between failure
MTTR	mean time to repair
NAMP	Naval Aviation Maintenance Program
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NAVICP	Naval Inventory Control Point
NAWCAD	Naval Air Warfare Center Aircraft Division
NEC	Navy enlisted classification
NEO	non-combatant evacuation operation
NFS	network file server/system
NIPRNET	non-secure Internet protocol router network
NITF	National Image Transmission Format
NRT	non real-time, near real-time
NSFS	naval surface fire support
NSWCDD	Naval Surface Warfare Center Dahlgren Division
NTSC	National Transmission Standards Committee
ODCM	Outrider DCM
OPCON	operational control
OPLAN	operations plan
OPORD	operations order

OPSEC	operational security
OT	operational testing
PANAMSAT	Pan-American satellite
PDCM	Predator DCM
PDU	power distribution unit
PED	processing, exploitation, dissemination
PEO-CU	Program Executive Officer-Cruise Missiles and Unmanned Aerial Vehicles
PiDCM	Pioneer DCM
PM	preventive maintenance, program manager
PO	payload operator
PSICP	program support inventory control point
RAID	Redundant Array of Inexpensive Disks
ROA	remotely operated aircraft
ROS	relief on station
RSTA	reconnaissance, surveillance, and target acquisition
RTP	real time processor
SAR	synthetic aperture radar
SATCOM	satellite communications
SB	sea-based/ship-based
SE	support equipment
SECDEF	Secretary of Defense
SHIPALT	ship alteration
SIGINT	signals intelligence
SIL	System Integration Laboratory
SINCGARS	Single Channel Ground and Airborne Radio System
SIPRNET	secret Internet protocol router network
SMTP	simple mail transfer protocol
SOF	Special Operations Force
SOP	standard operating procedures
SPINS	special instructions
SPTE	special purpose test equipment
SRO	Sensitive Reconnaissance Operations
SSN	attack submarine (nuclear)
STANAG	Standardization Agreement (NATO)
T&G	touch and go landing
TACON	tactical control
TAMPS	Tactical Aircraft Mission Planning System

TBD	to be determined
TBMCS	Theater Battle Management Core System
TBMD	Theater Ballistic Missile Defense
TCDL	tactical CDL
TCP	transmission control protocol
TCS	Tactical Control System
TEG	Tactical Exploitation Group
TES	Tactical Exploitation System
TIGDL	Tactical Interoperable Ground Data Link
TMDE	test, measurement, and diagnostic equipment
TOC	Tactical Operations Center
TTP	tactics, techniques, and procedures
TUAV	tactical UAV
UAV	unmanned aerial vehicle
UES	UAV Exploitation System
UHF	ultra high frequency
UPS	uninterruptable power supply
USACOM	United States Atlantic Command
UCARS	UAV Common Automated Recovery System
US	United States
USMTF	US message text format
UV	unmanned vehicle
VCR	Video cassette recorder
VHF	very high frequency
VMF	variable message format
VO	vehicle operator
VTUAV	vertical takeoff and landing tactical UAV
WOC	Wing Operations Center

PART II — TERMS AND DEFINITIONS

(except where noted as to source, all terms and definitions contained herein are specific to this CONOPS)

commonality —A quality that applies to materiel or systems: a. possessing like and interchangeable characteristics enabling each to be utilized, or operated and maintained, by personnel trained on the others without additional specialized training. b. having interchangeable repair parts and/or components. c. applying to consumable items interchangeably equivalent without adjustment. For TCS: use of the same hardware, software or user display. (DoD Dictionary)

compatibility — Capability of two or more items or components of equipment or material to exist or function in the same system or environment without mutual interference. (DoD Dictionary)

Dark Star UAV —Low observable (LO) HAE unmanned aerial vehicle capable of greater than 8 hours endurance at altitudes in excess of 45,000 feet at an operating radius of 500 nm. Also known as Tier III- UAV. Dark Star is capable of fully automatic flight. Dark Star is intended to provide critical imagery intelligence from highly defended areas. Air vehicle performance and payload capacity are traded for survivability features against air defenses, such as the use of low observable technology to minimize the air vehicles radar return. The Dark Star payload may be either SAR or EO. The air vehicle is self-deployable over intermediate ranges. The Dark Star UAV program was terminated by DoD in early 1999. (UAV Annual Report) [This definition has been modified to reflect current program status.]

endurance UAV — Unmanned aerial vehicle designed to operate at long range and with long on station times to support operational and theater-level units (normally Corps and above, and naval fleet operations) with deep penetration/wide-area surveillance. Endurance UAVs are autonomous, dynamically retaskable, medium to high altitude, long endurance, survivable UAVs that can gather and provide near real time, high quality imagery intelligence (IMINT) and signals intelligence (SIGINT) of areas where enemy defenses have not been adequately suppressed, in heavily defended areas, in open ocean environments, and in contaminated environments. (UAV Annual Report/Tactical UAVs Overview)

Global Hawk UAV — Conventional HAE unmanned aerial vehicle capable of a minimum endurance enabling it to transit 1200 nm (threshold)/3000 nm (objective), remain on station for 24 hours, at mission altitudes in excess of 60,000 feet and return to the launch base with appropriate fuel; currently under development as an Advanced Concept Technology Demonstration (ACTD). Also known as Tier II+ UAV. Global Hawk is capable of fully automatic flight. Global Hawk will be directly deployable from well outside the theater of operations, followed by extended on-station time in low- to moderate-risk environments to look into high-threat areas to provide both wide-area and spot imagery. Global Hawk can carry EO, IR, and SAR sensors concurrently and operate SAR and either EO or IR payloads simultaneously. Survivability derives from the very high operating altitude and self-defense measures. (UAV Annual Report)

HAE UAV — High altitude endurance unmanned aerial vehicle. Under development as an ACTD. (UAV Annual Report)

Hunter UAV — A tactical UAV originally developed to provide both ground and maritime forces with near-real time IMINT within a 200 km direct radius of action, extendable to 300+ km by using another Hunter as an airborne relay. Capable of operating from unimproved airstrips to support ground tactical force commanders. Operates at altitudes up to 15,000 feet and at ranges greater than 100 nm. Army currently maintains Hunter for training and as an operational contingency capability (UAV Annual Report)

integration — Two or more systems working together toward a common or mutually supportive mission.

interaction —A one or two way exchange of data among two or more systems/sub-systems.

interface — A point common to two or more similar or dissimilar C2 systems, sub-systems, or other entities at which necessary information flow takes place. Compliant with necessary protocols and formats. (DoD Dictionary)

interoperability — 1. The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. 2. The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and/or their users. The degree of interoperability should be defined when referring to specific cases. (DoD Dictionary)

jointness —The art of combining capabilities from the different military Services to create an effect that is greater than the sum of the parts.

MAE UAV — Medium altitude endurance unmanned aerial vehicle. The MAE UAV family includes the RQ-1A Predator UAV system currently in procurement and being operated by the Air Force. (UAV Annual Report)

modularity — The use of sub-systems or components from one system to function properly as part of another system. The interface at the sub-system level is sufficiently defined.

motion imagery —A sequence of images, with metadata, which are managed as a discrete object in standard motion imagery format and displayed as a time sequence of images. (NIMA Preliminary Motion Imagery Study)

non-real time processing — Non-flight critical processing accomplished within the host system software including interface to C4I system(s). Pertaining to the timeliness of data or information that has been delayed by the time required for electronic communication and automatic data processing. This implies that there are no significant delays.

Outrider UAV —A tactical UAV ACTD program to develop a UAV to support tactical commanders with near-real time IMINT at ranges beyond 200 km and with on-station endurance of greater than four hours. Originally designed to replace the maneuver UAV program by providing RSTA and combat assessment (CA) at Army brigade, Navy task force and Marine Corps regimental/battalion levels. Commonly referred to as TUAV. ACTD completed in late 1998. (UAV Annual Report)

Pioneer UAV — DoD s first operational UAV system, officially designated RQ-2A. Developed as an interim capability to provide IMINT for tactical commanders on land and at sea. Operates at altitudes up to 15,000 feet and at ranges greater than 100 nm. (UAV Annual Report)

Predator UAV — MAE UAV system, officially designated RQ-1A, designed to provide long-range/dwell, near real-time tactical intelligence, RSTA, and BDA with EO/IR and high-resolution SAR IMINT. Also known as Tier II UAV. Operates at altitudes up to 25,000 feet at a radius of up to 500 nm. (UAV Annual Report)

real-time processing — AV command and control info including antenna positioning and AV video receipt and processing. Pertaining to the timeliness of data or information that has been delayed only by the time required for electronic communication. This implies that there are no noticeable delays.

scalability — The characteristic that enables system components and capability to be tailored dependent on user needs.

still imagery — An individual image or image set, with metadata, which is managed as a discrete object in standard format and displayed as a static image. (NIMA Preliminary Motion Imagery Study)

tactical UAV — Unmanned aerial vehicle designed to support tactical units (normally Division and below, and combatant ships) with near-real time local area and battlefield RSTA and BDA to support their operations. (UAV Annual Report/Tactical UAVs Overview) *Through practice, TUAV has become the acronym used to describe the entire family of tactical UAVs.*

TCS operator — An individual specifically trained in the operation of the TCS system who is functioning at a TCS workstation.

TCS user — An individual not necessarily specifically trained in the operation of the TCS system who is receiving and using TCS-derived imagery products either directly from a TCS workstation or through a C4I system.

TUAV — originally referred to the Outrider tactical UAV, but through practice, has become the acronym used to describe the entire family of tactical UAVs. Army tactical UAV program is also referred to as TUAV.

video imagery — A sequence of images, with metadata, which is collected as a timed sequence of images in standard motion imagery format, managed as a discrete object in standard motion imagery format, and displayed as a time sequence of images. Video imagery is a subset of the class of motion imagery. (NIMA Preliminary Motion Imagery Study)

VTUAV - vertical take-off and landing tactical UAV. Navy/Marine Corps UAV program to develop a UAV capability focused on providing tactical support to maritime forces for afloat and shore operations.

waypoint control —Semi-autonomous or man-in-the-loop method of air vehicle control involving the use of defined points (latitude/longitude/altitude) to cause the UAV (air vehicle, sensor(s), or onboard systems) to accomplish certain actions.

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